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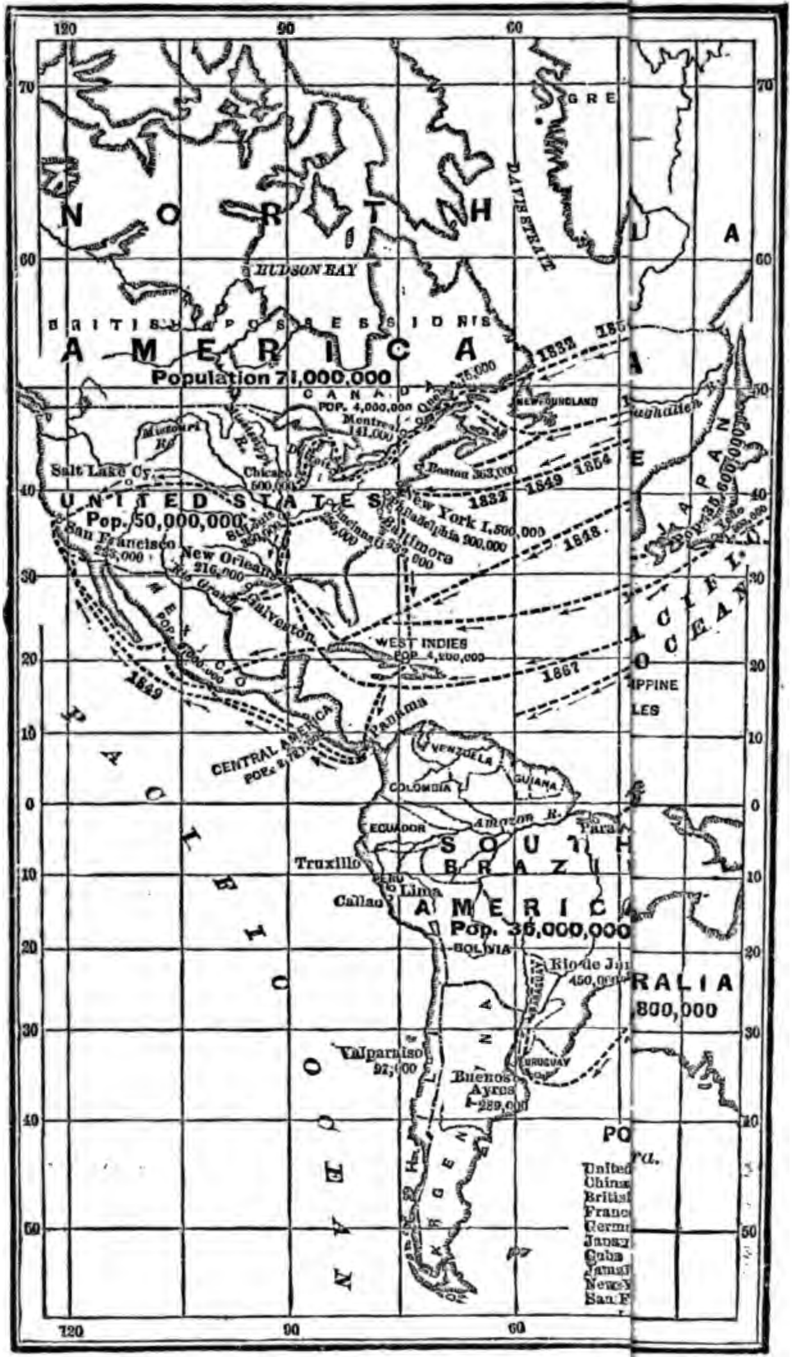

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Quebec 76,000
Montreal 141,000
NEWFOUNDLAND
Missouri R.
Salt Lake Cy.
Chicago 500,000
Boston 363,000
UNITED STATES
Pop. 50,000,000
New York 1,500,000
Philadelphia 900,000
Baltimore 332,000
Cincinnati
St. Louis
San Francisco 233,000
New Orleans 216,000
Rio Grande
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ILY, 1883

A TREATISE

ON

ASIATIC CHOLERA

EDITED AND PREPARED BY

EDMUND CHARLES WENDT, M.D.,

RATOR AND PATHOLOGIST OF THE ST. FRANCIS HOSPITAL; CURATOR AND PATHOLOGIST OF THE NEW
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JOHN B. HAMILTON, SURGEON-GENERAL U. S. MARINE HOSPITAL
SERVICE; AND GEO. M. STERNBERG, U.S.A.

Illustrated with Maps and Engravings

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PREFACE.

WHEN the publishers proposed to the editor the preparation, by a specified time, of a volume on Cholera, there was a very natural hesitancy on his part to accede to their request. Indeed, it was out of the question for a single individual in the given time to accomplish the task in anything like a satisfactory manner. However, having received assurances of coöperation from various sources, and especially after having secured the valuable collaboration of Dr. J. C. Peters, than whom probably no epidemiologist is better qualified to write on cholera, the editor overcame his misgivings and undertook to prepare the present treatise.

The object of the work is to furnish the physician with a faithful account of the actual state of our knowledge regarding a disease that, even at the present writing, is by many expected soon to visit our shores.

While the experience acquired in past epidemics has been utilized to its fullest extent, the contributors to this volume have not ignored the new light shed on the disease by the most recent researches. It is hoped that in this way the work may prove acceptable to a larger class of readers than if a more one-sided presentation of the subject had been undertaken. Of course the carrying out of such a plan has necessarily led to the embodiment of conflicting views, that may at times appear rather confusing.

Yet it is only in relation to the etiology of the disease that the discord of opinion becomes unpleasantly noticeable. Again, while the editor has not hesitated to freely express his own convictions, mere polemics and all theoretical disquisitions have been, as much as possible, avoided.

Being intended mainly for the American reader, it is fitting that the history of cholera as it has affected our own country, should receive special attention. Accordingly no apology is needed for the introduction of a very complete account of the disease as observed in the different American epidemics. And it is hoped that Dr. Peters' name furnishes a sufficient guarantee of the thorough manner in which this part of the work has been accomplished.

Dr. McClellan's history of the epidemic as it has affected the United States Army constitutes an authentic record of a highly instructive subject. Certainly nothing could furnish a more convincing proof of the agency of human intercourse in the dissemination of cholera than this part of the volume.

A chapter will also be found giving the history of the disease as observed in the United States Navy. The manuscript was kindly supplied by the Bureau of Medicine and Surgery of the U. S. Navy Department, and the editor takes this opportunity of extending his thanks to said Bureau.

It seems unnecessary to indicate in detail the plan and scope of the book. The editor may, however, be permitted to call special attention to the valuable article on the prevention of cholera, from the pen of Dr. J. B. Hamilton, Surgeon-General of the Marine Hospital Service, and the equally important contribution of Dr. G. M. Sternberg, on the destruction of cholera germs.

As regards the editor's contributions, it is not pretended to lay claim to any originality. His aim has been the modest and yet difficult one of drawing from the recorded experience of the best writers as much of the truth concerning cholera as was possible. But he feels much more certain of the importance of what was attempted than of the value of that which has been accomplished. Still, it is hoped that by collecting from widely scattered sources, information not easily accessible to the practitioner, and especially by ample reference to the most recent researches into the nature of cholera, the work may be found of sufficient merit to take its place by the side of other treatises on the same subject.

Of course the doctrine of Koch has received considerable attention, and a special chapter has been devoted to an accurate account of the methods of preparing pure cultures for purposes of diagnosis. As regards the etiology of cholera, the ground taken by the editor is that, while Koch's doctrine has not been finally established as a scientific truth, it has very much in its favor. At the same time space has been given to opinions directly traversing the points claimed by the German investigator. It will be seen, therefore, that the editor has treated the subject in an unbiased way. And indeed the extremely divergent opinions regarding cholera entertained even at the present day would scarcely justify an attempt to present a completely harmonious picture of the disease.

The editor has relied for information upon those American, English, French, German, Italian and Spanish writers who are recognized in their own countries as the highest authorities upon the subject. For valuable assistance in summarizing foreign writings he would here express his obligations to Dr. T. L. Stedman, of this city. His thanks are also due to Dr. J. C. Peters and Dr. A. Jacobi, for placing at his disposal their valuable libraries. Finally, the indulgence of the reader is asked for any typographical errors that, in the somewhat hasty proof-reading, may have been overlooked.

EDMUND CHARLES WENDT.

New York, May, 1885.

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The final outcome of recent pathological research, especially as regards the parasitic origin of many of our most formidable diseases, may result, as some suppose, in blurring the boundary lines that now separate them. But at the present writing, the tendency certainly is in a directly opposite direction.

It would be out of place here to discuss what is known as the "germ theory" of disease. Nevertheless it may be said that the doctrine which assumes that each infectious disease has its particular and specific microbe, is more in accordance with known facts than any theory yet promulgated.

It is not intended in this volume to describe the second and third varieties of cholera, the reader being referred to the standard text-books for an account of cholera morbus and cholera infantum. Nevertheless these diseases will incidentally receive some share of attention, especially in relation to diagnosis and differential diagnosis.

Etymology.—The etymology of the term cholera is somewhat doubtful. Most probably, however, it is derived from the Greek. By some it has been traced back to the Hebrew words, דע חלכ, pronounced choli-ra (bad disease). But Laveran[1] says that competent Hebrew scholars have shown the real meaning of these words to have been erroneously interpreted, merely on account of the similarity of pronunciation between choli-ra and the Greek for cholera.

χολερα, χολερη (Ionian) is certainly Greek. Hippocrates derived it from χολή (bile) and ῥέω (I flow), believing that the evacuations were caused by altered bile. Galen held that it was derived from χολάδες (viscera), as these organs were always first attacked in the disease. Celsus only admits the radical χολ, meaning bile, and this is without doubt the true derivation of the word. The Greeks were in the habit of adding to the word cholera the further designation of νοῦσος (disease), and it is doubtless for this reason that we find the Latin translation often rendered as *cholera morbus*. This was retained in English, although at the present day cholera morbus is used to denote sporadic or simple cholera, while Asiatic is added to the term cholera to qualify the epidemic or malignant variety.

Synonyms.—The disease under consideration has been variously known as Asiatic or Indian cholera, serous cholera, spasmodic cholera, malignant cholera, cholera asphyxia, epidemic cholera, algid cholera, blue cholera or cholera morbus, cholera pestifera. But in English it is most commonly called Asiatic cholera; in French, choléra Asiatique; in German, Asiatische or Indische cholera; in Italian, coléra Asiatico; and in Spanish, colera Asiatico.

Definition.—Asiatic cholera is a specific infectious disease which is endemic only in some parts of India. From there it may be conveyed all over the earth in the form of more or less malignant epidemics. An attack is, as a rule, characterized by premonitory diarrhœa, occasional nausea, muscular debility, faintness, and a sense of præcordial oppression. Next there arise the following symptoms: griping abdominal pains, frequent purging of a serous alkaline fluid resembling water in which rice has been washed or boiled, vomiting, a feeling of internal heat and actual external coldness. There also commonly occur suppression of urine, cold, clammy sweat, shriveling of the skin, pinching of the features, deep cyanosis, subnormal temperature, cold breath, intense thirst, a peculiarly husky voice, excessive restlessness, violent muscular cramps, and profound collapse, followed by speedy death or a reaction with or without fever. The British College of Physicians defines cholera as "an epidemic disease, characterised by vomiting and purging, with evacuations like rice-water, accompanied by cramps, and resulting in suppression of urine and collapse."

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[1] Article Cholera, in Dictionnaire Encyclopédique des Sciences Médicales. Paris, 1874, 1st series, vol. xvi.

PART FIRST.

A HISTORY OF ASIATIC CHOLERA.

SECTION I.

GENERAL HISTORY OF THE DISEASE AND THE PRINCIPAL EPIDEMICS UP TO 1885.

BY

JOHN C. PETERS, M.D.

OF NEW YORK.

NOTE.—For maps illustrating the routes of epidemic cholera in all parts of the world, the reader is referred to the end of Section I., Part First.

CHAPTER I.

EARLY HISTORY OF ASIATIC CHOLERA IN INDIA AS KNOWN TO EUROPEANS (A.D. 1503 TO 1800).

ASIATIC CHOLERA has always been present in Hindostan, or the land of the Hindoos, as long as that country has been known to Europeans. When Vasco de Gama rounded the southernmost point of Africa, which he called the Cape of Good Hope, with all the flags of his gallant little ships flying, his officers and men clad in their gayest clothes and brightest armor, and his trumpets sounding, he little thought he was soon to meet with a new and dreadful pestilence at the courts of the great King of Calicut, low down on the southwestern or Malabar coast of India.

He landed in 1498, and in 1503 Gaspar Correa, an officer of Vasco de Gama, says 20,000 men of Calicut died of a disease which struck them suddenlike in the belly, so that some of them died in eight hours.

In 1545 he met with it at Goa, further up the west coast, where it was called Morexy, "and the mortality was so great that the dead could hardly be buried; so grievous was the throe, and so bad the sort of disease," says Correa, "that the very worst kind of poison seemed to be in operation; as was proved by the vomiting, with great drought for water, as if the stomach was parched up; by the cramps that fixed in the sinews, with pain so extreme that the sufferer seemed at the point of death and the nails of the hands and feet becoming "black." In 1563 Garcia d'Orta, another Portuguese, gave a vivid description of cholera again at Goa, where it was now called *hachaiza, or haiza*, a name by which it is known throughout India at the present day; he says it was always most severe in June and July. In the meantime the Dutch, French and English had also sailed round the Cape of Good Hope to India; and Lindshot, a Dutchman, about 1589, while residing at Goa, wrote that *Mordexin*, a disease which comes on very suddenly, is common and deadly, as it attacks the stomach and bowels with continual vomiting and purging. Hence cholera was first met with on the west coast of Hindostan, south of and far away from Calcutta and the Ganges. In 1638 it again prevailed in Goa, and Thevenot was himself attacked with it, at Surat, still on the west coast and north of Bombay. The first Englishman who described cholera was Dr. Frye, who also saw it along the coast of Surat as early as 1563.

In 1628 Bontius, a Dutchman, described cholera at Batavia, far to the east of Bengal, and to which it must have been conveyed by ships.

It was noticed at Indore, near Central India, in 1621 and 1681; also at Mewar, far north of Surat, in 1621; again at Nagpore in the very center of India in 1666. At Bejapoor, a little north of Goa, in 1687; also at Masulipatan, north of Madras, on the east or Coromandel coast in 1687; and in Ceylon in 1639.

In 1733 it was seen at Madras; in 1739, at Delhi, far up in the north of India; in 1756 at Arcot, just west of Madras; in 1768 at Pondicherry, south of Madras; in 1777 at the mouth of the Ganges; in 1780 at Tranquebar, south of Madras; in 1781 at Juggernaut, south of Calcutta, and at Ganjam, near Juggernaut. It did not reach Calcutta, from Juggernaut, till 1782; nor Madras from Juggernaut till 1783, from whence it was carried to Trincomalee on the east coast of Ceylon also in 1783.

In 1783, too, it was at Hurdwar far up north at the foot of the Himalaya mountains at one of the great twelve-year festivals. In 1790 it was again at Juggernaut, near Chilka Lake, to which the idols of Juggernaut had been taken for safety against the Mohammedans who were besieging Juggernaut. It may be noticed here that the twelve-year Juggernaut festivals precede those of Hurdwar and some other places by two years. The Juggernaut festivals fell in the year 1781; those of Hurdwar in 1783. The frequent outbreaks about Madras were connected with the festivals at Arcot, Vellore, Conjiveram, etc., near by, as we will see hereafter.

One of the earliest English accounts is by Dr. Paisley of Madras, in 1774. He writes to Dr. Curtis: "I am glad you caused the army to change its camping ground, for there is no doubt the soiled ground contributed to the frequency and violence of the attacks of this dangerous disease, true cholera, which is the same we had at Trincomalee. It is often epidemic among the natives: in our first campaign it was terribly fatal among them, and fifty European soldiers also died. I have met with many cases since." The only claim of Calcutta and Bengal to priority in cholera is that given by Macnamara who says, "there was a temple to Oola Beebee, or the Goddess of cholera, near Calcutta, in 1720, which is visited by pilgrims to this day every Tuesday and Saturday, especially from April to June, in cholera times. The pilgrims fast in the morning, dine at two o'clock, when they eat crushed rice and a preparation of milk, and pay the priests."

The most suggestive early outbreak, which should have attracted more attention long ago was among Colonel Pearse's 5,000 troops marching in March, 1781, at Ganjam, near Juggernaut. He reports that in addition to those who died, there were 500 in hospital, on March 22, and says: "Death raged in the camp, with a horror not to be described, and all expected to be destroyed by the pestilence. I first attributed it to poison, but soon found there had been a pestilential disease raging among the natives in the parts through which our marches lay, and that part of our camp was drinking in death and destruction. In a few days, 1143 men were in hospital; but on March 26th there were only 908, and on the first of April the army was able to march again, leaving 300 convalescents behind." The supreme government report adds: "the pestilence found its way to Calcutta, chiefly affecting the native inhabitants with great mortality, and is also pursuing its course to the northward." This is the first authentic account of a Juggernaut cholera carried to Calcutta. It has since been repeated so frequently that the words: "cholera raging at Juggernaut, and beginning in Calcutta," are almost stereotyped. This epidemic was carried far up to the north, reinforced by pilgrimages to Gaya, just below Benares, to Benares, and Allahabad at the junction of the Ganges and Jumna rivers; and so on to Hurdwar, which it reached in 1783, as before said, at the great twelfth-year pilgrimage, which takes place there two years after the great twelfth-year pilgrimages to Juggernaut: for among the Hindoo priests there is the same rivalry as among the opposing sects of Persians, Arabians, Mohammedans, and among Catholics Protestants, and Mohammedans and Israelites. At Hurdwar in

April, 1783, in less than eight days, 20,000 pilgrims were cut off by cholera. How much further to the north it went no one knows.

But from Ganjam and Juggernaut it also went south with Col. Pearse's troops, and by infected natives to Madras. Dr. Girdlestone remarks: "Spasms of the bowels were the first disease which appeared among the European troops at Madras in October, 1782. More than fifty of these men were killed by them in the first three days after they arrived; and in less than three months upward of 1,000 had suffered from these complaints." He says there was coldness of the skin, especially of the hands; feebleness of the pulse, spasmodic contractions of the legs, coldness of the hands and feet, which were sodden with cold sweats, lividness of the nails, cold breath, insatiable thirst, and incessant vomitings, terminating in speedy death if not checked. By May, 1782, cholera had been carried to the English fleet at Trincomalee, on the east coast of Ceylon, and the Frenchman Sonnerat says it prevailed along the Coromandel, or east coast of India, especially in the neighborhood of Madras, from 1772 to 1782.[1]

In 1796 Fra Paolino Bartholomeo published at Rome a curious account of cholera on the west or Malabar coast, and says it was there called *Nircouben* in the Malabar language, *Mordexin* in Sanscrit, and not *Mort de Chien* or "dogs death," as it is called by Sonnerat. He says, "It is most frequent in October, November and December, when the cold winds come from the ocean loaded with salt and nitre: while on the east or Coromandel coast it is most common in April and May, when it often carries off thirty or forty persons in one village in one night. In 1782 it prevailed with terrible ferocity and destroyed an enormous number of people." None of these writers seemed to recognize the horrible filthiness of the Hindoo villages, but only talk about rains, winds, malaria, soil, heat and what not.

The Rev. Father Sangermano says it prevailed in Burmah far east of the Bay of Bengal in 178

It will be seen from the accompanying map that cholera did not originate in Bengal or Jessore in 1817, as is usually supposed.

It was noticed on the west coast of India long before it was seen on the east coast. It was felt at Calicut, Goa, Bombay and Surat, on the west coast, nearly two hundred years before it was recorded at Calcutta, Jessore, or Madras, on the east coast.

The same holds true to-day: Calcutta and Bengal unfortunately have not a monopoly of cholera, but all India is possessed with it. The Bengal official reports and maps indicate that there was no cholera in Bombay except occasionally, and then only when derived from Bengal previous to 1855. (See table of mortality for Bombay.)

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[1] The whole of this great epidemic of 1781 to 1783 was a great twelve-year festival outbreak, such as we will see was supplemented in 1817, or three times twelve years afterward; and extended from Juggernaut on the middle east coast to Calcutta and Hurdwar in the north; down to Madras and Ceylon in the south-east, and also over to the west or Bombay coast. The details of this epidemic are almost the counterparts of those which will now be given of the great outbreak in 1817.

CHAPTER II.

THE GREAT EPIDEMIC OF 1817.

In 1808 there were only five cases among the European troops; in 1811, 1812, and 1813, no less than twenty-nine cases at Chunar; and in 1814 there were deaths at Cawnpore, Nagpore, Benares, and finally at Dinapore near Calcutta—in all forty-six cases. In 1815 and 1816 there were no cases reported among the English soldiers. In short, from 1503 to 1817 there were no less than ten epidemic outbursts in India, so that it was no new thing for cholera to spread wide over the country; but there were so few Europeans dwelling there that they were not made public. Besides, no medical board was established till 1786, and its reports were not published till 1818.

The great epidemic of 1817 is usually supposed to have commenced in August at Jessore in the Sunderbunds, northeast of Calcutta and near the great city of Dacca, at the confluence of the Ganges and large Brahmapootra rivers. But it was only more severe at Jessore, and they were more frightened and made a greater outcry. Cholera was at Patna and Mymensing, far above Calcutta, in July; and was so severe in Calcutta itself in July that the government board returned word to the Jessore authorities that their pestilence was only the usual epidemic of the season, which had already been more fatal in the native or "black" town of Calcutta than at any former period in the recollection of the oldest inhabitants. And it was probable that no considerable town in the low and humid climate of Bengal was entirely exempt from it (Macnamara).

Still Dr. Barnes of Jessore threw much light upon the causes of the outbreak. He says:

> "They are not to be mistaken, although they are too extensive to be brought under human control. Putrid exhalations from the constant and rapid decomposition of animal and vegetable matter and the use of unwholesome water, are the sole causes. The atmosphere of Bengal is close, heavy, and moist; and the thermometer never lower than 75° F. from March to November." "In such a climate," continues Barnes, "any person acquainted with the materials that accumulate in Hindoo towns and villages, and with the crowded, filthy and unventilated state of the houses and streets, must be satisfied that these, of all others, are the conditions most favorable for the infection and at times even contagion. The huts of the poorer natives were surrounded with every kind of nastiness as well as stagnant water, and the exhalations from them were at times almost insupportable."

Dr. Barnes did not place much stress upon mere swamp malaria, but much upon what is now called "civic malaria." While he had so much filth directly under his eyes and nose, he troubled himself little about east winds, subsoil water, the barometer, or the so-called epidemic constitution of the air. He found enough on the surface of the earth without digging deeper or soaring higher.

The pestilence advanced so rapidly up the Ganges and over Bengal that by October, 1817, it had covered 195,935 square miles, and within this vast area the inhabitants of scarcely a single village or town had escaped its deadly influence. It had passed Benares, and reached the great distributing city of Mirzapore, near Allahabad, to the south of which the Marquis of Hastings' army of 10,000 men and 70,000 camp followers was moving still further south. Cholera commenced among the native camp followers with 97 deaths on November 13th, and the Marquis then said: "There is an opinion that the water of the tanks, the only water we have, is unwholesome; therefore I will move to the river Pohooj, though I have 1,000 sick." Nov. 15 he writes: "We crossed the river this morning. The march was terrible from the number of poor creatures falling sick from sudden attacks; and the quantities of those who have died in the wagons, whose bodies had to be thrown out without burial to make room for the new-comers; 500 died since sunset yesterday, ten of my body servants among them. The ground is sandy and porous, and there is an abatement of the contagion. Still numbers of dead and dying meet the eye in every direction. Nov. 17: The surgeons wish me to remain another day, but the stream is too small for our wants, and is muddy. I think of moving to the river Betwah, which is large and limpid. Nov. 19: we marched fifteen miles to this broad, clear stream which has lofty banks, and there is a favorable change. Nov. 21 there is an unquestionable improvement; no one can comprehend my sensations on hearing laughter in the camp this morning for the first time." The disease disappeared like magic; but not before over 12,000 had died.

The Marquis's account is one of the most graphic and touching that has ever been given. He says, after creeping about, as usual, for some time among the lower classes of camp followers, it suddenly burst forth with irresistible violence in every direction. The natives deserted in great numbers, and the highways and fields for many miles around were strewn with their dead bodies. The line of march of the white troops soon presented a most deplorable spectacle. The greater part of the sick were left behind, although all the baggage and ammunition were thrown away and the carts taken to swell the number of ambulances. Many who left the wagons, pressed by the sudden calls of the disease, were unable to rise again, and were necessarily abandoned. Hundreds dropped down at every day's advance, and more were left behind at every night's halt. The places of encampment and lines of route presented the appearance of a deadly battle-field and the track of an army retreating under every circumstance of defeat and discomfiture. He gave instructions, if he should die himself, that his body should be buried privately in his own tent to prevent a panic among his troops. Some of his own table servants had dropped down while waiting upon him and his staff. We are here reminded of the sudden outbreak in Col. Pearse's army, near Juggernaut, in 1781, and in Col. Crockett's force near the same place in 1790.

A considerable force of Madras troops was marching up from the south to join the Marquis of Hastings. It had suffered many privations and much fatigue and excessive heat, but had had no cholera until it got to Nagpore in central India, where we have seen cholera had been in 1666. Col. Adams had scarcely heard that the pestilence was in his vicinity before his troops, which were in high health, were attacked, especially while loitering for water at the neighboring rivulets; seventy were seized the first day and more than twenty died the first night.

From Nagpore the great high-road southwest to Bombay, by way of Jaulnah, Aurungabad and Poonah, was soon involved by the troops, in spite of a strong southwest monsoon which was blowing directly from the Arabian sea.

In the meantime troops were also being sent up from Bombay toward central India, and pilgrims going to the great festival at Punderpoor, below Bombay, crossed their line of march. A great outbreak took place and 3,000 pilgrims died in the course of a few days, and the rest on their dispersion carried the pestilence in every direction. Punderpoor has often since played a great part in the Bombay epidemics.

The progress of cholera from Nagpore, in central India, down to Bombay had been carefully watched and traced from city to city and village to village, creeping or even jumping along by the arrival of persons from places known to be infected. Some towns escaped for months where this sort of communication was not frequent, or the water supply was good. It was pronounced capable of transportation from place to place. It was regarded as infectious, but only under some peculiarities of the constitution of the patient, or of the local conditions of the place, or of its water supply. Surgeon Coats thought if it was occasioned by some general distemperature of the air it would have spread over the country with more regularity, and have attacked all parts of a town more equally. But it seemed only to travel over roads, and when the population was scanty and the intercourse slight its progress was slow.

The Presidency of Bengal contains much more than one-half of the whole population of India. The valley of the Ganges is perhaps the most populous in the world and has the greatest number of large towns, cities and villages. The pilgrimages to every part of the Ganges are numerous and even almost incessant. Hence the progress of cholera in Bengal seemed confused and indeterminate. But as soon as it reached central India, where the population is sparser and the roads fewer, and every objective point was watched by intelligent and responsible army surgeons, the more or less regular and progressive advance of the pestilence was at once noted, and that it marched even against the most powerful monsoons and winds.

Cholera prevailed in the Bombay Presidency in 1818, 1819, 1820 and 1821, and over 150,000 town and country people died of it. During these years it also traversed almost the whole of India. From Allahabad, a somewhat central city toward the north, it was carried up to Lucknow, Oude, Delhi, Hurdwar, Lodiana, Lahore, and even to Peshawur in the extreme northwest.

From Nagpore, in the very center of India, it went directly south to Hyderabad, Bejapoor, Gooty, Bangalore, Seringapatam, Mysore, Bellary, Madura, and down nearly to Cape Cormorin, the southernmost point of India.

From Juggernaut it traveled down the east coast to Madras against the heaviest winds and the southeast monsoon, and was carried in ships over to Trincomalee in Ceylon, and from thence in ships to Mauritius and Madagascar.

From Calcutta it was sent northeast by land toward Burmah and China, and southeast to Batavia, Java, and the Philippine Islands and to China in ships. No winds could have carried it throughout the Eastern Archipelago without its attacking many more islands than it did. It only broke out in those in which it was landed from ships.

From Bombay on the west coast it was sent in ships to Muscat and other places on the Persian Gulf. In 1821, 800 English troops under Col. Thompson were sent to Muscat to punish pirates. They carried the disease with them and landed it on the east coast of Arabia. It also prevailed in Surat and Kurrachee, and from these three cities 120 British and 130 country vessels were going every year to the Persian Gulf. The harbor of Muscat is so land-locked that few winds can blow into it; and it is distinctly stated that it was brought there in ships.

It was also carried to Bushire, far up the Persian Gulf, and to Bassorah at the very head of it, by English ships. At Bassorah 18,000 are said to have died in the course of a few weeks, doubtless from water contamination, and from there it was transported up the river Euphrates to Bagdad, which became affected as well as the surrounding country. A Persian army lay before Bagdad, and lost over 2,000 men in a short time, and then retreated north, carrying the disease with it as far as Tabreez, just between the Black and Caspian seas.

Kerbela and Meschids Hossein and Ali, those great places of pilgrimage, became involved, and pilgrims and travelers carried it to Aleppo, Antioch and Damascus, almost to the east coast of the Mediteranean sea, where it died out in 1823.

From Tabreez it was carried up between the Black and Caspian seas to Tiflis in the Caucasus, whence it went through the only mountain pass, that of Dariel toward Russia, and finally reached Astrakhan both by land and by ships from the foot of the Caspian sea. It arrived at Astrakhan in September, 1823, where it died out in the winter and did not reappear until six years after, when it was reimported.

Many assumed that cholera was blown over the Caucasus mountains, which are 6,000 feet high. In 1822 the pass of Dariel was a mere mountain road; next it became a Russian military road, and now a railroad leading straight to Moscow runs through it. Cholera has been carried through it again and again by soldiers and travelers.

CHAPTER III.

THE EPIDEMIC OF 1827 IN INDIA, WHICH REACHED RUSSIA IN 1829, ENGLAND IN 1831, AND THE UNITED STATES IN 1832.

In 1820 there was little or no cholera in India. In June 1821 it prevailed to such an extent near Juggernaut that the idol car could not be dragged about as usual. In 1823, Juggernaut and its neighborhood again suffered severely. In 1824 it was in central India and far over toward Bombay. In 1825 it was again at Juggernaut with Calcutta also suffering severely. Early in 1826 it was evidently on the increase in all Lower Bengal. By May 13, 200 or 300 cases died per day at the holy city of Benares, half way up the Ganges. In November, 1826, it was far up above Allahabad on both the Ganges and Jumna rivers, and at Delhi and Agra. In May, 1827, it was again at Agra with a very large number of victims, and in June again in and around Delhi to an epidemic extent. It was then found that it had been at Hurdwar, further north, in April. In June it had spread up the sides of the Himalaya mountains to the height of 3,000 feet. It was all over the northwest provinces in 1827, especially at Lahore, one of the most northern cities. Suddenly it was heard of far west at Teheran, the capital of Persia, near the foot of the Caspian sea, but not until early in 1829. Then it was discovered that it had been at Cabul in Afghanistan, just west of India, in 1827 and 1828. Lieutenant Connelly met with it at the important city of Herat, still further west, in 1828 and 1829, and said that cholera had swept away many thousands of persons in and around Herat.

The question now arises, How did cholera get to Cabul, Herat and Teheran? It was generally assumed that it was blown over the tops of the Himalaya and Suleiman mountains. But

According to Lieutenant-colonel Sir Alexander Burnes (see "Narrative of a Journey to and Residence in Cabul in 1836, '37 and '38," p. 77), the most extensive arrangements have long been made to convey pilgrims, merchandise, and disease to and from Hurdwar and Central Asia.

The Lohanee Afghans are a migratory, commercial, and pastoral people who proceed annually into India to purchase merchandise. At the end of October, as winter approaches, they descend into India, remain until after the fair at Hurdwar, and commence their return toward the end of April. They all reach Cabul and Candahar by the middle of June, in sufficient time to dispatch their investments to Herat and Bokhara; and then pass on into Khorassan in Persia, where they remain during the summer. They march in three great divisions; the first has twenty-four thousand camels; the second nineteen thousand, and the third seven thousand. It is with these that the Hindoo merchants, and foreigners generally, travel. This channel of trade is very ancient, dating before the time of the Emperor Baber, A.D. 1505.

These large caravans go through the Bolan and Kyber and other mountain passes through which every invasion of India from the west has taken place. Alexander the Great and his Greek troops took these routes; also Gengis-Khan, and all the Mohammedan conquerors of India. The English, it is well known, have made several invasions of Afghanistan through them.

The arrangements for the conveyance of pilgrims, merchandise, and disease further west are still more complete, according to Sir James Connolly. Due west of Herat, lies Meschid, the *Holy City* of North Persia. For eight months in the year all the roads to and from Meschid are thronged with pilgrims. Nearly sixty thousand come up from India, Cabul, and Afghanistan, and as many more from Turkey in Asia, the Caucasus, and shores of the Black and Caspian seas. Meschid lies half way between Herat and Teheran.

Herat has great historical and present interest. The Russians have newly arrived near there. It is surrounded by one of the most fertile plains in the world, about forty miles in diameter, which produces grain, cattle, fruits and vegetables in profusion. It is watered by numberless bright streams and rivulets, and a jackass load of grapes, peaches, melons, etc., can be bought for 50 cents. An army once there will require nothing but clothing, arms and ammunition. The food and water questions require no attention. Herat has been visited by cholera again and again. In 1828 King Mohammed and Prince Koursan, the last members of the royal family of Afghanistan, fell victims to cholera, and left the succession in dispute up to the present time.

At Teheran, in 1829, there was the greatest consternation. The Shah of Persia and his court fled to the mountains, the nobles and people followed his example, to escape the pestilence. From Teheran cholera was carried for the second time to and up the Caspian sea to Astrakhan in the north, at the mouth of the great river Volga, where it empties into the Caspian ; and also by land by way of Tabreez and Tiflis, and again through the Pass of Dariel, just as it had gone before in 1822 and 1823.

But it was destined to reach Orenburg first, high up on the Volga, by another route. From Herat it was also carried northwest by caravans to Balk, and Bokhara the most holy city of central Asia, and is even said to have been at Cashgar in 1827 and 1828. Then it was forwarded to Khiva on the sea of Aral, and from thence to Orenburg, which is the border trading town of Russia, and also a strong military post. It had a garrison of 16,000 men and others doing outpost duty toward Khiva. The first victim on Aug. 26, 1829, was a soldier; the second an officer. The Khurgis tribes who brought goods with caravans seemed to escape, and the introduction of the disease seemed a mystery. In fact, the cases were so few that they were not recognized till Sept. 10. Finally they admitted that it had raged among their people, and it came out finally that some of them had died of cholera in Orenburg, but the deaths of these obscure people were easily concealed. Then it also was discovered that the Khan of Khiva had commenced a campaign toward Persia, but at Khorassan had been compelled to retreat on account of an outbreak of cholera which swept away a large portion of his army. From Sept. 9 to Oct. 21, 1829, 747 deaths occurred in Orenburg. At first it was supposed not to be infections and certainly not contagious; but it was inferred that well persons coming from infected districts brought some of the atmosphere with them which then poisoned the air of the new place. The diarrhœal origin and infection were overlooked; soiled clothes were not examined or looked for, but clean merchandise was severely quarantined.

From Orenburg it was carried west, by August 27, 1830, to the great fair of Nishni Novgorod, where 300,000 to 400,000 merchants, etc., assemble in July and August of every year. From there it went to Moscow, to which it was also coming from the south, from Astrakhan, and up the Volga, spreading over all southern Russia and toward Austria, Hungary and Poland.

A determined effort was made to save Moscow by means of quarantine and cordons. The Emperor of Russia, through his medical advisers, announced his fullest conviction that cholera was not a miasmatic disease generated in the soil and carried about by the winds, but by persons and soiled clothing only, not by clean merchandise; that it spread by a species of infection, then called contingent contagion. Twenty cholera hospitals were provided, one for each ward or district into which the city was divided, with police officers, physicians, clergymen and a magistrate for each section. Barriers were placed between each division, so that if the pestilence broke out in one ward it might be prevented from spreading to the others. Cholera was apparently kept out of Moscow for a long time, although it prevailed in every province around it. Finally it stole in in so many different paths by means of diarrhœal cases that no exact information has ever been gained how it first made a lodgment. The people took alarm, and 50,000 of them stole away before stringent measures were instituted. The epidemic was well under way by Sept. 18, 1830, and from the 24th to 28th it was called sporadic and indigenous and then all means for preventing its entrance after it had long been in, were enforced in the most vigorous manner, and also to keep a pestilence in which had already got out. A double military cordon was put around the city, with troops and loaded cannon everywhere; all the bridges were destroyed, and wagons, horses, and vehicles seized. Infected persons were isolated; their clothes washed in chlorine water or vinegar, and fumigated with burning sulphur. The physicians washed their hands and faces with vinegar and rinsed their mouths with it; were careful not to swallow their saliva, and breathed through sponges soaked in vinegar when in the vicinity of severe or fatal cases. The physicians generally escaped, but ninety-three clergymen died. Nearly 9,000 cases in all occurred, for they did not then know how to disinfect the discharges.

From Moscow it was also carried to St. Petersburg, on the 26th of June, 1831, and Drs. Russell and Barry, of the Indian service, who had been familiar with cholera in Hindostan, were sent by the English Government to observe the disease. A triple cordon of troops was placed around St. Petersburg to keep out the cholera; but Drs. Russell and Barry state that the first case occurred in a person who came down the river Neva, in a bark with goods from Moscow; the second in an individual who had been on board the bark upon its arrival; and the third in a soldier who had mounted guard on the boat to prevent any intercourse with the shore. From St. Petersburg it was carried down to Cronstadt, on the Baltic, and a new current of the disease was then let loose to visit Hamburg, Bremen and England. The winds had blown east to St. Petersburg for 51 days, west 32 days, and variably 9 days. The east wind was accused. St. Petersburg had no sewers at that time, and got most of its drinking water from contaminated surface wells. The people understood this so well that they accused the government, doctors, apothecaries, Jews, and all strangers of poisoning the wells. Huge riots broke out in which many doctors were injured and some killed. Finally nearly 10,000 of the lower classes broke the cordon and spread themselves over the country, sometimes carrying the disease with them. Finally it got up as high as Archangel on the White sea and Frozen ocean.

In the meantime the great Polish insurrection of 1830 had taken place, and Russian troops from many infected provinces had been sent to the neighborhood of Warsaw. Many battles took place, in some of which the Poles beat the Russians, took possession of their infected camp-grounds, and captured arms, food and clothing. It then commenced in the Polish army, which was finally beaten back to Warsaw, introducing the disease there.

Almost the whole of the Prussian and Austrian armies were employed in huge cordons against the cholera in Russia and Poland, but people were seen running the lines and were fired upon every night. In addition, Prussia allowed Dantzic to be used as a depot of provisions and stores for the Russian army, and its harbor was crowded with Russian transports. It is needless to say that cholera broke out badly in Dantzic.

To complete the folly, the whole Polish army finally crossed the boundaries of Austria and Prussia, laid down its arms, and surrendered to them rather than to the Russians. Cholera was quickly in Hungary and Austria, but especially it was carried to Berlin and from there to Hamburg and Bremen, and from thence over to England. Still it was not destined to reach England first in that way.

From Moscow it was conveyed early in May, 1831, to Riga, and it is distinctly stated that it was brought to the headwaters of the river Duna, at the mouth of which Riga is situated, and was carried downstream to that city. Immense alarm arose, and on June 3d no less than sixty vessels fled in haste from Riga, four of which were destined for England, especially for Sunderland, on the east coast. By October 26, 1831, an official English report declared that three hundred and six cases and ninety-four deaths had already occurred in Sunderland, and the first case of cholera in London occurred in the person of a man from Sunderland. From London it was carried to Dover, and over to Calais and Paris, in France. From England it was carried to Scotland and Ireland, and in the spring of 1832 vessels from Dublin and Cork conveyed the disease over the Atlantic to Quebec.

Greville, secretary of the Privy Council of England, was sent up to Sunderland to obtain information, which he says it was very difficult to procure. The medical men and higher classes were split into parties, quarreling about the nature of the disease and concealing the facts which militated against their respective theories. Dr. Danby, the health officer, complained that physicians would send him no information, and a strong government order was put forth to compel them. He winds up: "For a long time the truth was quite unattainable in Sunderland. Falsehood was propagated with such zeal in every quarter that the medical and daily press were almost universally imposed upon." A trunk of clothes belonging to a sailor who died of cholera at Riga on the Baltic was sent to his home in Maine; the contents were given to his relatives, some of whom, according to the late Dr. C. A. Lee, died of cholera in that State.

In Sunderland the fiercest disputes arose about the origin and mode of arrival of the disease. It was known that some Sunderland sailors had died in Baltic parts on board of coal vessels, and their clothes had been sent back. The first persons attacked in the port resided on the quay and were exposed to intercourse with the shipping. It was subsequently proved that cases had occurred as far back as the 5th, 14th, and 29th of August, and were not reported, or were concealed. This was two months before the acknowledged importation of the pestilence.

There were only 97 deaths in all England in November, 1831; 282 in December; 614 in January, 1832; 708 in February; 1,519 in March; and 1,401 in April.

The emigration to Canada and New York was so great in 1832 that cholera reached both these distant places almost before it was carried from London down to Paris. On March 24, 1832, cholera broke out suddenly in Paris, and according to M. Gendrin, on the third day of its appearance he received patients from many districts in Paris into the Hotel Dieu. He observes that the patients' distant residences and opposite professions precluded the probability of their having derived their disease by contagion, or from human contact. The disease was so virulent, that of the first 98 cases 96 died. Within a week the mortality reached 500 a day, and the cases to four times that amount, and in eighteen days no less than 7,000 persons had died of it. To every one conversant with cholera this tremendous outbreak was not brought to it by the winds, but was certainly connected with water contaminated with cholera discharges and filth. It also goes without saying, that it did not reach its great proportions in three days. In fact it commenced as early as March 1st, which was no fool's day for Paris. Grisquet, the Prefect of Police, exerted himself to suppress the pestilence, but the rag-pickers rebelled against the order forbidding garbage, dirt and rubbish being thrown, as usual, in the streets and raised barricades. Others thought the disease was brought and propagated by the government, aided by physicians and apothecaries, and the latter were insulted and assaulted. In fact, the pestilence had been spreading slowly for six weeks before the great outburst, the cause of which has only been made manifest by Dr. Marey in his little brôchure called "Les Eaux Contaminées et le choléra. Paris 1884." He marked on a plan of Paris every house which had had deaths from cholera, and then hunted up the water-supply. The left bank of the Seine suffered slightly, the right severely; the latter was supplied largely from the canal de L'Ourcq and the river Seine. The former at La Villette is exceeded in its amount of market boats and shipping only by Marseilles and Havre, all the filth of which goes into the canal; the water is filthy dock water; in addition many sewers empty into the canal, as others do into the Seine, and yet this nasty water was supplied to the greater part of Paris for drinking and cooking. In every epidemic in Paris, even that of last year, 1884, the canal de L'Ourcq has played the same distinctive part.

In all the epidemics in Paris and many other places the most wearisome and complicated tables are given of the age, sex and occupation and married or single state of the sufferers, the state of the thermometer and barometer, the direction and strength of the winds; the amount of heat and rainfall; even the side of the house and the story in which the patient dwelt; the nature of the soil, etc., etc. All of which gives scarcely a gleam of the nature and causes of cholera. Fortunately the amount and kind of civic filth is often given, and occasionally a hint that the water supply was bad. All the early cases in Paris were overlooked or concealed, and it has never been made known how the pestilence arrived there. It was at Calais, from England, before it reached Paris and probably also in Havre from

Hamburg. Of 20,000 inhabitants in the Luxemburg quarter 7,552 were indigent and 13,330 well-to-do. Of the former 4,500 suffered from cholera; of the latter only 2,500. Before the advent of the epidemic in France it was reproduced in England and Ireland, especially in Hull, York and Leeds, but there were only 14,796 cases and 5,432 deaths.

I will finish with the epidemic in Europe before following it to America. Up to this time Spain and Portugal had escaped: then, the London, a transport steamer, sailed from England to Oporto, on Dec. 25, 1832, with troops for Gen. Polignac: not a nice Christmas gift, and arrived on New Year's day, 1833, having lost seven men by cholera; the disease appeared on land on Jan. 15th. Spanish quarantine was rigorously enforced, except among the troops. Every other traveler from the infected district was detained, and even threatened with death and confiscation of goods, if he did not go through all the formalities; and also all those who harbored him. But cholera broke out soon, of course, in many provinces in Spain, reached Madrid, and was even carried over to Barcelona on the east coast.

In the meantime it had been brought down from Paris to Marseilles and Toulon, and also forwarded east to Villafranca, Nice and Cannes. By August 12th it was at Turin and soon after at Genoa on the west coast of Italy. By November, 1834, it had reached Venice and Trieste on the east coast and the Adriatic sea. In October, 1836, it appeared in Naples in spite of a most rigid quarantine at the port, but it slipped in overland, from Milan and other places. The physicians traversed the streets covered from head to foot with black wrappers of wax cloth into which two pieces of glass were introduced for eye-holes. In Rome alone there were 9,372 cases and 4,519 deaths.

It soon spread down to Sicily, and is supposed to have been carried east to Malta, on June 9th, 1837, followed by 3,893 deaths among the people and 815 cases and 578 deaths in the English garrison of 3,070 men. The Mediterranean fleet suffered considerably, but only after it had touched at Palermo or Malta.

But another stream of the disease, which had been overlooked, was coming up from Mecca as early as 1831, brought there from India. Nearly one-half of the pilgrims died, especially in the Syrian caravan, and the governors of Mecca and Jeddah, the seaport of Mecca. It was carried up to Suez and Cairo in Egypt, and from there to Alexandria on the Mediterranean in August; and had also been pushed up the old route to Asia Minor. In July it was at Constantinople, whether brought up from Egypt, or over from southern Russia, or both, no one knows. But this much is certain, that it almost reached Vienna from the west by way of France and Italy, almost before it got there from the east by way of Russia; so that at this early date there was no excuse for assuming that cholera always traveled west like the young man; especially as it was known that it had been carried east to China as early as 1821.

CHAPTER IV.

THE FIRST EPIDEMIC IN THE UNITED STATES, THAT OF 1832.

CHOLERA had prevailed, as we have seen, in Russia in 1829 and 1830. It reached England, Scotland and Ireland in 1831, and was first landed at Grosse Island, the quarantine station for Quebec, on April 28, 1832, by the ship Constantia from Limerick, Ireland, with 170 emigrants, of whom 29 had died of cholera on the voyage. On May 14th, the ship Robert, from Cork, arrived, having had 10 deaths from cholera. On May 28th the ship Elizabeth, from Dublin, came in with 200 passengers, and 20 deaths from cholera. On June 3d the brig Carrick, from Dublin, followed with 145 emigrants and 42 deaths from cholera. Total, 375 emigrants and 159 deaths from the pestilence. There was no proper quarantine, all who seemed well were forwarded at once from Grosse Island. The soiled clothing was not washed, and disinfection was unknown. There was constant and uninterrupted intercourse by sailing and steam vessels, which took off all who wanted to go from the quarantine to Quebec and even to Montreal. So energetically was this done that from June 2d to 5th no less than 750 emigrants had been taken from Grosse Island to Quebec and some to Montreal, and before the end of the summer nearly 30,000 were forwarded up the river St. Lawrence. Deaths were of course so common that no special attention was paid to cholera or any other disease. So little did the Canadian authorities know about what was going on, that they long attributed the whole outbreak to the brig Carrick, and fixed the 3d day of June as the date of the first case of cholera in North America.

A glance at any school map will show that no winds except exceedingly intelligent ones could have blown cholera from England and Ireland to Quebec without first attacking Nova Scotia, Prince Edward's Island, Newfoundland, Anticosti, New Brunswick, some part of Maine, or of East Canada before reaching Quebec; nor could they have pursued a directly northwest course up the Gulf of St. Lawrence to latitude 49° and then suddenly have turned down the river St. Lawrence due southwest, without the aid of pilots, helmsmen and ships.

Up to September 2d there were 2,208 deaths from cholera in Quebec, of which 56 occurred in the first two weeks of June in Roache's emigrant boarding-house. Again it is generally supposed that the steamboat Voyageur carried cholera from Quebec to Montreal by June 9th; but we have seen that cases were sent there before that, and the Montreal officials knew as little about its commencement as did those of Quebec. In the first two weeks there were 800 deaths, and by September 1st, 1,843.

From the St. Lawrence the disease was forwarded along Lake Ontario by steamboats, and by land along its northern or Canadian border. Those places where no passengers were allowed to land escaped. From Montreal the pestilence commenced to descend Lake Champlain by means of emigrants and travelers toward Albany and New York. Every eye was turned toward Canada, when suddenly it appeared in the city of New York on June 24th, before it could easily be traced to any arrival from Canada, although the arrival of trunks from Leeds, Canada, was subsequently reported. If it did not come from Canada it would have required the same wonderful intelligence on the part of the winds to blow cholera past New Jersey, Long and Staten Islands, Brooklyn and Jersey City, into the heart of the lower and east part of the city. All the records of the arrival of ships at New York during April, May and June, 1832, have been removed, while those before and after are complete. Dr. Vaché and Dr. Alonzo Clark state that a cholera ship arrived at New York in June. The sick were cared for at the quarantine, and the well were shipped to the city and up the North River as rapidly as possible. There was a race of cholera from Canada and New York city to Albany, which it reached July 3d and finally caused 1,104 cases. By July 12th it was at Schenectady coming from Albany; and on the same date at Rochester from New York. July 15th it was at Buffalo among canal boatmen, and among emigrants by the 30th.

Cholera in New York City in 1832.

New York city should have been well prepared for the reception and proper management of cholera, but it committed almost every mistake of ignorance and prejudice, or worse, that has ever been promulgated. The diarrhœal commencement of the disease was already well known, but it was assumed that the pestilence was in the air and not in the bodies and discharges of the sick. Because it was not directly and immediately contagious it was declared not to be even infectious. Although it was a specific and most peculiar disease, it was asserted that all its causes were only merely those of common diarrhœa, and ordinary cholera morbus.

In the official report every fanciful notion was jumped at, and all the most patent facts overlooked. It was asserted that easterly and southeasterly winds had prevailed in Canada and brought the disease across the ocean. That influenza had prevailed in 1831 and foreshadowed cholera, especially as aged and weak people could not bear full doses of Tartar emetic. That scarlet fever was malignant and often attended with diarrhœa. That intermittent fevers were common in the lower parts of the city, and sometimes showed great prostration and even collapse, when they were of the congestive kind. That cholera morbus and dysentery occurred in the winter in unusual proportions, and the air was evidently taking on an epidemic choleraic constitution. That on July 16th vomiting, diarrhoea and cramps appeared among a tribe of Indians 100 leagues from the sea, when the true disease had been in the country for more than two months. That attempts to trace cholera to vessels at Quebec were not successful, although the first cases were among emigrants; this was attributed not to infection, but solely to the crowded and filthy condition of the emigrant houses; for did not the pestilence break out in a low and uncleanly and ill-ventilated part of the city of Quebec, then crowded with a large population of emigrants of the lowest description. The sickness on board the Carrick and other cholera vessels was declared to have been mainly ship-fever and small-pox; and although there had been some cholera on board these vessels, yet there had been no cases for thirty days previous to the arrival of some of them. In the first two weeks, (more correctly months) there had been 1,000 deaths, which excessively large number could only have come from a general distemperature of the air, which spared 1,000 where it attacked one. The conveyance by soiled clothing was overlooked.

In Montreal great stress was laid on the fact that on the same night of June 9th, when the Voyageur arrived, several native inhabitants sickened in various parts of the city remote from the docks and from each other, before having had communication with the port or landing place, and most if not all of these died in twenty-four hours; but we have already seen that cholera was landed April 28th, May 14th, May 28th, and June 3d. The Voyageur we now know was not the first steamboat laden with cholera which went from Grosse Island and Quebec to Montreal. Many diarrhœal cases had been landed and had wandered all over Montreal, or many parts of it. In two weeks, or more likely two months, 800 persons died of it, and this so-called rapidity of generation and progress is erroneously said to have outstripped the emigrants and reached Detroit early in July. But we now know the very steamboats by which it was carried to Detroit.

Again, it is incorrectly stated that without having shown itself at any intermediate spot between Canada and New York it appeared in New York city in the person of a Mr. Fitzgerald, an Irish emigrant, who arrived in Quebec in the autumn of 1831, and lived in Albany from September to May, and on the 3d of May took a first floor of a house in Cherry street, near James street. He was a steady and temperate tailor, his wife was a neat housekeeper, and they committed no imprudence in diet. On June 25th he spent the day in Brooklyn, sickened in the night, but soon recovered. Early on the 26th two of his children were attacked, and both died on the 27th. On the 28th, after eating strawberries and being exposed to the infection of her husband and children, who had not eaten strawberries, the wife was attacked and died.

Fitzgerald is the man who is said to have received a trunk of soiled clothing from Leeds, Canada, although some say it came from Leeds, England; he was a recent emigrant, and may have had close connections with Canada and even Ireland or England. It is certain that his diet and surroundings did not cause Asiatic cholera, which had already been quietly and secretly introduced into New York by the ship Henry IV. and others.

The second reported case in New York was also an Irishman named O'Neil, seized the same day in Greenwich, two miles away from the first cases. He died the next day in the Greenwich hospital. He had been drunk for a week and had fallen into the North River, perhaps where some cholera ship had docked. The next day, June 30th, a lodger of a Mr. Hannasy, No. 15 James slip, near the first cases, was seized and died July 1st. He was temperate and careful, but was not known to have had any communication with the first James street cases. Another lodger sickened and died the same day in the same house July 1st. The keeper, Mr. Hannasy, and several others were subsequently taken sick and died either there or at places to which they were removed. All the latter were intemperate, and the house was most disgustingly filthy; but those causes alone could not produce Asiatic cholera; while the signs of infection were very manifest.

On July 2d, cases (how many?) occurred near the same locality, viz., in Water street, on the East river, near James street. By July 4th it had shown itself in various places upon the opposite or west side of the city. From this time cases continued to multiply daily, and Dr. Dudley Atkins, secretary to the special cholera medical council, hardily says, "All efforts to trace these cases among Irishmen to any foreign source have thus far been wholly unsuccessful."

By July 3d public alarm was excited to the highest degree and a special medical council was appointed and continued to serve until the decline of the epidemic. This council consisted of Dr. Alexander H. Stephens, President; Drs. Joseph Bayley, Gilbert Smith, John Neilson, Wm. J. MacNeven, Hugh McLean, Richard K. Hoffman and Anthony L. Anderson. We will soon see how they, and perhaps the secretary, were misled by the Common Council. The Record office in the Park was turned into a cholera hospital, and in nine weeks from July 1st to Sept 1st there were 2,030 patients and 852 deaths there, with 1,189 recoveries. Medical stations were appointed in each ward. About July 1st the disease appeared at the Almshouse, Bellevue, but cases of a so-called doubtful nature had occurred in June, but were not seen by the house physicians, as they were only paupers. These first doubtful cases were in all parts of the Almshouse quite distant from the ward in which the case of July 1st occurred; so that the whole house was already infected. In all there were precisely 555 cases and exactly 300 deaths, neither more or less, according to these so-called accurate figures.

Dr. Thomas T. Devan was the physician of the Bellevue cholera hospital; from his report we learn that the first case was brought there in the person of Joseph Dean, colored, aged 16, who had been sweeping streets in the first ward of the city, and was admitted to the Almshouse not on July 1st, but on June 25th, about dusk, having sickened with diarrhœa on the 18th or 19th. He was sent to Blackwell's Island, where he recovered, and no other cases occurred on that Island till July 10th.

On June 26th, Richard Bostwick, colored, aged 83, who had been lying in the same ward, viz., No. 3, of the Almshouse in which Dean had been put, was attacked with vomiting, purging and cramps, and died next day. He was an old resident, had been in the Almshouse since 1829, and was long supposed to have been the first case, who had been nowhere and done nothing to bring on cholera, which had been blown in the windows as they were open during the day, though shut at night.,

The third case in the Almshouse was on June 27th, and the next two on July 1st, in room 19. Then the disease began to show itself in every part of the Almshouse; no place except room 4 escaping its ravages. Total to August 10, 547 cases, 315 deaths, and 232 cures.

Dr. Joseph Bayley of the special medical council was appointed to investigate the outbreak in the Almshouse, and incorrectly says the first case was Mary Bloomfield in ward 19, who sickened July 1st, and died on the 2d. She had not been in New York city for several years, but it was not ascertained whether she had received visitors from the city; still 54 persons had been taken in the Almshouse from June 24th to July 1. After her death two other women occupying adjoining beds to Mary, and who had been in the city, also sickened and died, as did the nurse, who had not been in town. Here are all the signs of infection, which has been strenuously denied to this day. Mary doubtless contracted her cholera from the women who had been in the city, and being weaker, merely died sooner.

Again, Daniel Ryan was sent from the Almshouse to the general hospital of Bellevue on July 3d, and died the next morning. Also George Elliott and George Riley, who had been frolicking about the city on July 4th, were sent to the Almshouse July 5th, rallied, and then drank cold water and died. Then Joseph Herring, in hospital from April 9th for chronic diarrhœa, but sleeping between Ryan and Elliott, died on the same day, July 7th, that he was attacked. Then Catharine O'Neal, sister perhaps of the second city case, had been a few days in the city, returned to the Almshouse June 30th, and was sent from there to the hospital, where she died July 3. Then Ann Barnes, sent from the Almshouse July 4th, died on the 5th. The first resident living in the hospital attacked had been there from April 25th, was seized July 6th, after Catharine and Ann had been admitted, and she died next day, followed to the grave by several other female patients.

It has always been erroneously maintained that all the first victims in the Bellevue Almshouse were old residents: that no new-comers were attacked; that the infection was not brought by persons or things into the Almshouse or hospital, but was blown in by the winds and the general distemperature of the air; in proof of which the exact size of the doors and windows were carefully given, and the size of the chimneys.

When one can get at all the facts, most all of the mysteries about the introduction of cholera into hospitals and prisons can be easily cleared up; or rather they clear themselves up.

Dr. Bayley curiously enough omits all the cases before July 1st, and says: "From the 1st to the 8th of July, eight days, there were 68 cases. From the 9th to the 16th, also eight days, 278 cases. From the 17th to the 24th, also eight days, only 96 cases."

Not the least ray of light was shed upon this tremendous multiplication of the disease. There must have been water contamination; but not a word is said about the water supply. The Croton aqueduct was not completed until 1842. Bad well or pump water must have been used. There were no sewers, and out-door privies must have existed; how near the wells they were no one now knows; night pails were probably used in the sick wards, and a fæcal atmosphere pervaded them.

To return to New York city: Dr. Atkins says: "The disease was of an atmospheric character, caused by a general distemperature of the air, yet it was confined for the most part to a few portions of the city, so that there were definite and limited or localized neighborhoods, which were to a remarkable degree more sickly than others. Of these the Five Points, a resort of the vicious and dissolute, was most heavily visited. This was originally a swamp, and although filled in, must be low and damp," and cholera hence was primarily malarious. The other parts of the city where the pestilence chiefly prevailed were low, dirty and unhealthy, with narrow streets and filthy dwellings, inhabited by the lowest and poorest people. Duane and Vestry streets escaped, and as I have lived in both of them, I know all about them; one of them has always had a nice little park, and the other was near the magnificent old St. John's park.

The three lowest wards near the Battery were then residences of the best part of the population and escaped also, except Broad street; but at 26 Broad street, not far from Wall, three ladies, four nurses and servants died in a few days, in a fine house. A child also, aged 4, which had been in this house only one day, died. The ladies were "ladies;" the nurses were healthy and temperate, but there was a small rain-water drain under the basement, and hides and horns were stored in a cellar near by. Hence the disease was malarious, although the laborers who cleared out the hides were not attacked, and the hides were sound and dry, and not at all offensive.

> "The dissolute and intemperate mostly were attacked, viz., drunkards and prostitutes. Still, very small irregularities in diet were sagely decided to be highly dangerous to the nicest people; thus everybody who took huckleberries, or even raspberries and milk; were decreed to be doomed to death. In one house in Madison street, a father and three children were all dead in twenty-four hours after eating raspberries. Although the disease was said not to have been imported, the low Irish suffered most, not because they received infection from emigrants, but because they were dirty, intemperate, and crowded together in the worst portions of the city."

If this were true, cholera would never be absent from our tenement houses. Cellars and basements furnished the greater proportion and worst form of the cases: upper stories were comparatively exempt; hence the disease must be malarious. Back buildings in courtyards were very subject to cholera: in one in Sheriff street, out of forty inmates, of all colors and countries, said to be filthy and vicious, 23 had diarrhœa, which went on to collapse in 9, and to death, in 7; of which 6 were young children who could not have been intemperate or very vicious. Other like houses produced 6, 8, 13 and even 18 cases. It often happened that one crowded house would show only two cases daily until all had been affected, or else moved away; but again in other like houses only one case of real cholera would occur, the other inmates having a harmless diarrhœa only, although the house itself was both crowded and dirty. The attacks generally came on in the night, excited by the cold, malarious night air. Attendants upon the sick were sometimes attacked, but the majority of such cases were either intemperate or imprudent, or very susceptible to the disease, having come from Brooklyn, where the pestilential and epidemic constitution of the air were not prevailing, and they therefore were destitute of that so-called protection which was enjoyed by those who were acclimated yet dying by hundreds in the city. It was often observed that those about the sick had diarrhœa; but the significance of this in spreading the disease was not dreamed of.

But Dr. Atkins might have guessed better, for he tells us "that cholera was almost universally preceded by diarrhœa in New York," which he says "should be called malignant diarrhœa, or choleraic diarrhœa; and public attention," he further says, "should be called to it loudly; for then only is the disease manageable." He also says he "cannot leave this subject without paying a tribute to Dr. Kirke of Greenock, Scotland, to whom is due the praise of having been the first to ascertain and publish the general fact that diarrhœa is an almost universal precursor of true cholera." He suppresses the great fact that Dr. Kirke thought the diarrhœal discharges infective; and merely says to the knowledge of the first fact we owe the preservation of the lives of thousands in this city and throughout the country. If he had proclaimed the second great truth he would have saved many more thousands. And if he had been equally frank about the known importation of the pestilence into New York he would have saved tens of thousands. Dr. Atkins sums up the causes of Asiatic cholera, thus:

> 1st. A peculiar, imaginary state of the atmosphere producing a tendency to diarrhœa. He says nothing about the atmosphere from the discharges. 2d. People are inclined to sweat in summer and be weak and languid, and may have cramps in their legs if they tire themselves; this is a choleraic sweat which, turned in on

the bowels, may cause diarrhœa. 3d. The alcoholic diathesis of Dr. I. M. Smith. 4th. Low, damp, malarious situations: civic filth-malaria is still worse. 5th. Persons with irritable bowels, subject to diarrhœa, are very liable to cholera, especially inmates of almshouses and prisons when fed only on mush and molasses and soup without much meat, or solid food. I believe that they are just as safe as in ordinary times, provided they do not swallow the germs or poison of cholera. 6th. Eating unripe, or even ripe good fruit, or vegetables usually deemed digestible, also milk, especially if eaten with fruit. 7th. Venereal excesses and debauchery, especially a midnight spree. 8th. Anxiety of mind caused by fear of the disease, or eating a little fruit, from the sickness or death of relatives, or worry about business in cholera times. 9th. Getting wet in summer showers, or by going to fires, as firemen. 10th. The only really wise thing he points out is that the smell of choleraic discharges has in some instances been observed to produce sudden vomiting and purging in a healthy person; and the air of houses where persons were sick with malignant cholera has been known in about twenty instances to produce cholera in nurses; but these were mostly persons fairly predisposed to the disease by fatigue, nursing, anxiety, etc. 11th. He says, also truly, that a number of very interesting facts have been stated which go far to prove that cholera is at least sometimes infectious, if not contagious. Dr. King, of Newport, writes to Dr. Alexander Stephens that on July 17th, two ladies left New York for Newport, arrived on the next day, were detained in quarantine for one week and then allowed to leave on the 25th, both suffering from malignant cholera of which both died, one in the evening and the other in the very night on which they landed; but the red tape of a week's quarantine had been faithfully observed. On the 30th, Mr. Foster who assisted them and buried them was attacked with what was called bilious diarrhœa and colic, from which he recovered and then relapsed several times and then survived; but his wife and three children were attacked with real cholera, and the wife and two children died. The second Foster attacked was a nursing child aged 18 months, who died August 4. The mother died on the next day, then a child aged 3 years was seized the same day, but recovered; and at noon another child aged 10 years, which died the next day. Then two hospital nurses who attended them, sickened and died. The town of Newport was perfectly healthy and had no diarrhœa when the first cases arrived. The Foster house was in good order and in a healthy part of the town, so that there was no ground to suspect special local causes or even a general distemperature of the air.

Dr. Ellwood reported to Dr. Atkins that a man attended some friends sick with cholera at Rochester and then went to his home at Mendon, sixteen miles distant, and died of cholera on the following night; of six persons who attended and buried him, not one escaped an attack, and four died within a week. There were afterward 13 more deaths among 150 people. At Manchester, Ontario county, also in Oneida county, and at Ancram, near Hudson, similar cases were reported, with from four to six deaths each.

Dr. Atkins discusses these troublesome facts ably from his point of view, viz., that the disease is either atmospheric, or telluric; *i.e.* that it must come either from the air or ground. First he says it is of course in the air and then that it comes from the ground; else it would not be more common in low, damp and filthy places than on high and dry spots. He again says it comes from the air which is heavy and does not settle on high places, but sinks down into the low spots where it becomes perhaps compressed, condensed and virulent. Again he incorrectly states that the disease has traveled too rapidly to have been carried in any other way than by the air, when he knew that it came not only in ships to Quebec, but also to New York. He says it appeared in Quebec first on June 9th and the very next night broke out in several parts of Montreal, all of which we have seen is incorrect. He insists that great stress should be laid on the untruth that it has been impossible to connect the idea of importation from any foreign source with the first cases in New York; as these had been nearly two months in the city when no cases were further south than the frontier of Canada, when it had not only nearly reached Albany but had been absolutely let into New York. The so-called first case was reported in New York on June 25th, and was not the first case any more than July 1st was the earliest date in Bellevue Almshouse. It was acknowledged in Albany on July 3d, but was preceded by what is called disorder of the bowels.

No one would suppose from the narrative above given that cholera had actually been let into New York by ships in June, as soon or almost as early as it was landed at Quebec; and that by the connivance of the authorities ships with cholera on board had come to the Staten Island quarantine; the sick had been treated secretly there, and the well, or apparently well, had been forwarded to the city and up the North river to the west as rapidly as possible. Most of their baggage was unventilated and unwashed. Of course the first cases in the city must also have been concealed. But on June 19th, before it was landed here, Wm. Shaler, U. S. Consul to Havana, then in New York on leave of absence, asked for information from the board of health in favor of Cuba. He writes June 19th for whatever information the board might possess about this awful visitation of Providence, as well as the measures of precaution which might be taken to prevent its introduction and propagation in New York and the rest of the country. He says such information will be regarded as evidence of kindness by Cuba and humanity, thereby preventing loss of life and injury to the immense commercial relations, especially perhaps the latter. The medical council replied to them July 16th, hopefully, not having been informed of the arrival of cholera ships at New York, to the following questions.

1st. *Whether the malignant cholera, as it now exists in the City of New York, can be prevented by sanitary or quarantine regulations?*

We (the special medical council) beg leave to say that many statements have been made which go to show that the disease is transmissible from one place to another by persons affected with it. The council are unwilling to put forth opinions which would be at variance with the great weight of medical authority in this direction; at the same time it feels bound to declare its conviction that no quarantine regulations hitherto employed and known to us have been, or we fear are likely to be, effectual in excluding the malignant cholera from any populous town or village on this continent.

2d. *When it comes, what are the best means to mitigate its malignancy?*

The strictest attention should be given to the removal of all the common causes of disease; all privies, sinks, sewers and stagnant pools of water should be cleansed; the dwellings of the poor should be thoroughly purified and whitewashed; crowded houses should be emptied and the sick removed at once to large and airy hospitals. All persons should be strictly temperate, and no excess should be indulged in. No fruits or any other than simply farinaceous vegetables can be eaten with safety. Uneasiness in the bowels, slight cramps and dizziness should be attended to. Looseness of the bowels should be treated by *purgatives*, especially calomel. If any diarrhœa is neglected, cholera is its usual sequel.

3. *When it comes, what are the best means to protect life against its attack?*

It is important to allay the vomiting and purging, and if the patient is not enfeebled by previous disease, general bloodletting is found to mitigate the spasms and render the system more susceptible to the action of the grand remedies, mercury and opium: 20 or 30 grains of calomel with 2 grains of opium and a large mustard plaster over the stomach. Small portions of ice chewed and small doses of tincture of camphor will quiet the stomach. The calomel is to be repeated every one, two or three hours, till the stools become bilious; friction, with rubefacients; dry heat with bags of hot sand. If the skin be moist, then hot powdered chalk may be well rubbed in. If the pulse becomes feeble and the skin cold, rub in two parts of strong mercurial ointment with one part of camphor and the same of red pepper. Injections of hot brandy and water in large quantities of green tea frequently repeated will prevent collapse.

The secondary fever must be treated with bloodletting, purgatives and small doses of nauseating medicines. The dead should be buried quickly; the rooms purified by chlorine gas, and thorough ventilation [although the latter would let in the generally distempered air]; and the floors should be washed with hot lye. The corpse should be covered with cloths soaked in a solution of chloride of lime.

The whole body of the people should be swayed by great moral principles,[such as let in cholera secretly, and scrupulously and rigidly observe all the means of protecting life.] Beef, mutton or chicken, plainly cooked, eggs slightly boiled, bread made of wheaten flour only, rice and mealy potatoes, should form the whole diet. We fear this list cannot be extended without introducing less wholesome articles. Even beans, peas, peaches, raspberries, puddings containing raisins, are dangerous.

These directions ruled the practice of the whole United States and have not lost all their influence to-day.

New York sent cholera to Newport, R. I., by July 17th; to Boston by July 30th; to Newark, New Jersey, by July 7th; to Philadelphia, July 5th; to Delaware, Aug. 6th; to Baltimore, Aug. 4th, although a cholera ship with 19 deaths had arrived previously at the latter place, of which no cognizance was taken by the health authorities; to Washington, D. C., Aug. 8th, where several thousand laborers, mostly emigrants were engaged in street-making; there were over 1,000 cases and more than 500 deaths. It was sent to Charleston, S. C., from New York by the brig Amelia.

It will be seen anon that cholera has never been blown by the winds from Europe to any part of the coast of New Jersey, Pennsylvania, Virginia, North or South Carolina, Georgia or Florida; nor to any of the West India Islands, but gets into the Gulf of Mexico by means of ships. By February, 1832, New York sent cholera to Havana with 10,000 deaths out of 100,000 inhabitants; and from there it went to Tampico, Campeachy and Vera Cruz, Mexico. At Tampico there were 900 deaths in 17 days. It was even sent back again to New Orleans from Havana. In 1834 cholera was again sent to Quebec from Dublin and up the St. Lawrence river, and down to New York by August 9th, where it had already commenced July 9th, by its own importations, which were again concealed. But it cost the city only 827 deaths.

The great mortality of this first epidemic is now attributed to the then exclusive use of surface wells and out-door privies. Water contamination was almost universal; but the disease was generally ascribed to a fanciful epidemic constitution of the air, and to be excited by the most trivial imprudences in diet, while the clothes and discharges of the patients were entirely neglected; and the movements of infected persons and of their baggage to and fro was overlooked.[1]

CHOLERA IN NEW ORLEANS IN 1832.

In 1832, Dr. Joseph Jones says cholera and yellow fever swelled the mortality to 8,000 out of 55,000, the death rate reaching the enormous proportion of 147 per 1,000 inhabitants. It came down from Chicago and St. Louis in October after the arrival of the steamboat Constitution with cases on board, many others having died. It frequently passed over plantations where no diarrhœal cases arrived to attack others further off. Poor Surgeon-General Lawson was in a wonderful doubt whether it was wafted down the Mississippi by the winds, or came in the atmosphere of the steamboat; he placed no stress upon the dead and dying. He said it first attacked the poor and intemperate; still others could stalk about uninjured, but some could not peep out of their windows without catching it. In the first quarter of 1833 there was only one death; then it was sporadic till April; gradually increased in May, when it again became epidemic and committed great ravages among all classes of citizens, about 70 dying per day. The Charity hospital was completed that year and had 252 cholera patients with 136 cures, 73 deaths and 43 remaining. Acute dysentery, 215 cases, 161 cures and 50 deaths. Cholera morbus, 9 cases 4 deaths; malarial dysentery, 25 cases 4 deaths; chronic dysentery, 61 cases 29 deaths; typhoid dysentery, 8 cases 7 deaths; diarrhœa, 29 cases 2 deaths; and 169 deaths from various other forms of bowel diseases. These probably were filth-dysentery and diarrhœa. In all there were 4,740 deaths from cholera in 1832, and it lingered through 1833, with 1,000 deaths; and then there was no more until 1848.

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[1] For more minute information see United States report of the cholera of 1873, by Dr. Ely McClellan, U. S. A., and Dr. John C. Peters.

CHAPTER V.

CHOLERA IN INDIA FROM 1830 TO 1845.—IN ASIA, EUROPE AND AMERICA TO 1849.

CHOLERA had almost subsided in India in1829; in 1830 it was only present in Bengal and in the neighborhood of Bombay. In 1831 it was very severe near Gaya up the Ganges, near Benares, and other places of pilgrimage; this was repeated in 1832 and 1833. In 1834 it spread to the northwest provinces, and also to the east, far up the Brahmapootra river. It was frequent in Madras, and also in the central provinces in 1833 and 1834. This is the epidemic outburst which it is supposed was carried to Mecca in 1835, and got out into the Mediterranean sea in 1836 and 1837, and met that arm of the pestilence which was coming from the west of Europe.

In 1835 cholera almost faded down in India, and 1836 was another year of rest; but it was again very active in 1837. It began now to be noticed that cholera was apt to prevail every three or four years, and two theories about this were started; one pointing to the pilgrimages which increase in sanctity every third, sixth, ninth and especially every twelfth year; the other calling attention to the effect of drought and rain. In very dry seasons cholera almost died out, to spring up again with the first rains and to be drowned out by excessive rainfall. In 1838 it was common in the northwest provinces, and in 1839 it passed over the borders into Cabul after having ravaged almost every large station in Bengal; and again in 1840. In 1841 it broke out at Juggernaut and spread over almost all India, and again in 1842 and 1843. In 1844 it faded down again.

In 1840 the Chinese opium war broke out and English troops and vessels carried the pestilence to the Eastern Archipelago, where it had not been seen since 1821 and 1826; and also up to China, where it stayed and raged in 1841, 1842 and 1843, and finally was sent west through China and down south into Burmah toward India again; and also still further west through Central Asia to Cashgar, Yarkand, Kokand and Bokhara; and from there down to Cabul and south into India through the northwest provinces. It also went down the river Indus to Kurrachee, where it caused that tremendous outbreak in 1846 which is so celebrated in the horrors of cholera; causing 410 cases and 238 deaths in the 86th regiment, and no less than 800 cases in a few days. This was connected with water contamination. Cholera had prevailed moderately for some time when a severe rainstorm came on and washed cholera filth into the wells.

In this curious epidemic cholera was first carried far east to China; then forwarded west through China to Central Asia, and from there down into the very heart of India. This was "carrying coals to Newcastle," or rather cholera to India, "with a vengeance." But this extraordinary epidemic also traveled still further west; after coming down from Bokhara to Balk and Herat it turned west also to the holy city of Meshid and from there was carried to Teheran, the capital of Persia, and from there to and between the Caspian and Black seas, and again up over its old route to Tiflis, Astrakhan and southern Russia, which it reached in 1845 and 1846. In September, 1847, it was at Moscow and the great fair of Nishni Novgorod; and soon the whole of Poland, Moldavia, Wallachia, and even Finland and Sweden, was under its influence. From 1847 to 1849 there were over one million of deaths from cholera in Russia alone. It had broken out in Berlin as early as July, and in September in Hamburg, and in Holland; and a few cases occurred in France toward the end of the year 1848. It was carried from Hamburg to London on Sept. 18, 1848; and to Edinburgh by Oct. 4, also to Hull and Sunderland, from Hamburg. It was in Belfast, Ireland, from Edinburgh by Dec. 2.

Cholera in the United States in 1848 and 1849.

On November 9, 1848, the ship New York sailed from Havre for New York, and it was said there was no cholera in Havre when she sailed; and no one probably will now ever know whether there was or not. When sixteen days out, cholera commenced after trunks had been opened containing clothing of some who had died of cholera in Germany. Before her arrival seven of the steerage passengers had died and eleven others had sickened with cholera and were sent ashore at the Staten Island quarantine. The next day the number of cases had increased to 20, with 8 deaths; finally there were 63 cases and 29 deaths; but the disease did not spread to the city, although it was known that numbers had escaped from the quarantine and gone over to New York; while considerable intercourse had always been kept up by visitors. Two cases occurred among escaped emigrants in a German boarding-house; the rest were scattered over the city, and yet no epidemic followed them. The winter soon set in quite severely and the disease entirely subsided.

On October 31, 1848, the ship Swanton left Havre also with a clean bill of health, and when twenty-seven days at sea, on November 26th, the first case of cholera occurred. The weather had become very warm and the passengers opened their trunks and boxes for thinner clothing; they were German emigrants. The winds which blew the ship along did not land cholera in any part of Florida, or of the West India Islands, nor in Alabama or Mississippi, nor at any part of the river below New Orleans. The Swanton arrived December 11th, 1848, having had thirteen deaths and more than double that number of cases of cholera at sea. No quarantine had been established, and the usual disputes arose about the origin of the disease in New Orleans, as cases, supposed to be indigenous, had occurred before the arrival of the Swanton. Then Dr. Fenner proved that the Guttenberg from Hamburg had arrived December 6, with 250 emigrants, after a fifty-five days' passage, with numerous deaths from cholera. One of the earliest cases in New Orleans was from this vessel. Next, at this late date, it was found that the Callao from Bremen had arrived on December 8th with 150 emigrants and 18 deaths from cholera. This epidemic cost New Orleans 2,500 deaths. On Dec. 20 the steamboat Convoy brought the disease from New Orleans up the Mississippi river to Memphis. Dec. 27 the Amaranth brought it to St. Louis, followed by others. Dec. 22 the Peytona, and Dec. 24 the Savannah, brought it back to New Orleans and established another but mild epidemic. Dec. 25 it was brought by steamboat from New Orleans to Cincinnati. Thus the pestilence was carried up the Mississippi, Missouri and Ohio rivers and even reached Chicago, Buffalo, Detroit and Niagara Falls before it was brought west from Canada or New York. The emigration was very great in 1849, as gold had just been discovered in California. As the principal starting-place for over the plains was St. Louis, that city suffered more heavily than any other place. It was carried thence across the country to Sacramento and San Francisco. The Indians also suffered very heavily, as well as the emigrant trains and United States troops.

In the meantime several other cholera ships had arrived at New York, but the disease did not declare itself in the city until May 11, 1849, when it commenced in a lodging-house in Orange street and was followed by 5,017 deaths. In the interval the whole West was overrun with cholera from New Orleans. Among others it was carried up the Mississippi and Ohio rivers to the Cumberland and down south along that river to Nashville, Tennessee, by the Caroline Watkins and other steamboats. In almost all these places the disease was declared to be malarial and of local origin. Dr. James Wynne was the principal disseminator of this plausible but erroneous doctrine, and was ably seconded by Dr. Bell of Louisville. Some of their notions of the spontaneous origin and purely malarial foundation of cholera are very curious indeed. For instance, the outbreak in the Baltimore Almshouse in July, 1849. Although Dr. Nathan R. Smith proved that a poor English emigrant had called at his office in Baltimore on July 5th and had been removed to the Almshouse, where he died on the 7th, yet Dr. Wynne persisted that the disease was not imported. The whole house, 800 feet long, and the grounds, seemed in splendid condition and had nearly 700 inmates. But just outside of the north wall there was a large filthy pool, the contents of which were in a state of actual fermentation from the drainage into it of a large pig-sty, the washings from the dead-house, an overflowing privy, and from the wash-house where all the soiled linen was washed. This was called pure fever-and-ague malaria. Of the inmates 53 were discharged, 62 escaped and of the rest 99 died of cholera. Those on the basement floor nearest this mixed civic filth, called simple malaria, suffered most, and in one ward all died. Those in the upper stories and on the sides furthest removed from the filth suffered least; but some who were much in the yard died in the attic where they slept. The germs were imported into the house, and the immense amount of festering filth multiplied the disease. The hospital part of the building was unwisely placed nearest the filth, and the mortality was necessarily great. Disinfection was unknown, and the discharges were thrown into overflowing privies. This is the pivotal case of all the doctrines about the so-called pure malarial origin of cholera in the United States; and how slender the basis of it is, is evident.

One of the most curious cases of infection was that of Buffalo, to which it was brought by steamboat from Chicago up Lake Michigan and down Lakes Huron and St. Clair. It arrived in Buffalo May 13, 1849, whereas it did not commence in New York till May 11th. The Chicago cases came from St. Louis and New Orleans. Another case was sent to Buffalo from Cincinnati via Sandusky, June 1st, and on June 4th another was brought by steamboat from Chicago. Buffalo had 858 deaths in this epidemic up to Sept. 7, 1849.

The pestilence was not only carried north from New Orleans but also south to plantations in Louisiana, in the majority of which cases the conveyance of the infection could be distinctly traced. In January, 1849, it was carried to Mobile, with only 149 deaths, as that city generally escapes lightly, owing, it is said, to the pure drinking water with which the city is supplied. It was also taken to Texas from New Orleans by the 8th United States Infantry. General Worth died of it at San Antonio on May 7. It was diffused through Texas by the movements of troops and emigrants and carried into Mexico by refugees from Texas. The Mexicans had a lively recollection of the cholera of 1833, and most of them fled.

The emigration to the gold fields was so great that New Orleans was fed with constant arrivals from Europe, and again sent cholera up the Mississippi and beyond in 1850 and 1851. Eight or ten cholera-laden steamboats arrived at St. Louis and aroused the disease afresh, and seventeen of her physicians died. On April 20th the Illinois and Michigan canal was opened to Chicago, and on the 29th the John Drew arrived from St. Louis with passengers and emigrants directly from New Orleans, followed by 314 deaths. On April 21st the Sacramento arrived at St. Joseph, Missouri, with a large number of California emigrants, and then the Mary with over 50 deaths. These emigrants carried the disease over the river Platte route and finally brought it to Sacramento, in October, 1850, at almost the same time that it reached San Francisco by the steamship Caroline, from Panama, to which it had been brought also by steamships from New York. The Platte Indians contracted the disease, and committed daily murders on the unoffending whites whom they supposed had secretly poisoned them. By July, 1849, it commenced to arrive at Buffalo, Chicago, and the west from New York.

Louisville, Kentucky, as usual, escaped with slight outbreaks; for it seems, like Lyons in France and Wurtzburg in Germany and Mobile in this country, a city of refuge from the disease, although it occasionally has severe, but circumscribed outbreaks. In July, August and September, 1849, there were only five deaths in New Orleans, but on Oct. 15 the Cromwell from Havre arrived with 204 steerage passengers, of which twelve had died of cholera. She was ordered to the opposite side of the river and her passengers were forwarded to St. Louis the next day. On Oct. 15 the steamboat General Lane and others brought it down the river. Oct. 23 the Berlin from Liverpool arrived with 206 Scotch and English emigrants, with 40 deaths, and her passengers were also at once sent up the river. Of course during November cholera prevailed to an alarming extent, and on the 26th the Gypsy from Liverpool, where the disease prevailed, arrived with 322 emigrants and 19 deaths. On the 27th came the Fingal, with 322 passengers and 37 deaths. Hence the disease lasted over till 1850 in New Orleans. Then the Falcon arrived from Panama, Chagres and Havana with 25 deaths, the disease being epidemic in all these places. The pestilence did not extend east of the Alleghany mountains. Prior to May, 1850, St. Louis had 953 deaths; Cincinnati had 1,400; Sandusky lost 18 per cent of her population. Whole parties of miners and emigrants were decimated on the great western plains.

From New Orleans it was also carried back to Cuba and the Isthmus of Panama. And thus the pestilence went to and fro as travel predominated. No East, West, North or South was exempt from it. San Francisco only lost 250; Sacramento suffered far more heavily, for out of 8,090 inhabitants, 4,000 fled, and of the remainder 1,000 died.

In 1848 there were no less than 1,616 deaths from cholera in New Orleans; in 1849, 3,176; in 1850, 1,448; in 1851, 430; in 1852, 1,320; in 1853, 585; none in 1854; 883 in 1855; 43 in 1856; 24 in 1857; 26 in 1858; 27 in 1859; 30 in 1860; 12 in 1861; none in 1862; 4 in 1863; 5 in 1864; 9 in 1865; 1,294 in 1866.

CHOLERA IN ST. LOUIS, MISSOURI, 1848–1853.

This city was the most interesting and important receiving and distributing point of cholera in 1849 and the subsequent years. Its full history has been written only quite lately by Dr. Robert Moore, C. E. We have seen that cholera was brought to New Orleans early and late in December, 1848. During the last week of this month several steamboats came to St. Louis from New Orleans with the disease on board. The first was the Amaranth, Dec. 28th, with 30 cases. On Jan. 2, 1849, the steamboats Aleck, with 36 cases, the Scott and St. Paul with 26 cases, arrived; on Jan. 7th the Gen. Jessup with many cases and six deaths. All these boats brought many infected emigrants, who with all their infected baggage were landed and scattered through the city without the slightest delay or hinderance; hence on the 9th several cases were reported, which were said to be sporadic, and caused by cabbage. The pestilence was now fairly planted, and for the next four years was never wholly absent from St. Louis. In Jan. 1849, there were 36 deaths; in February only 21; in March, 78; in April, 126. On April 12 the steamboat Iowa came from New Orleans with 451 Mormon deck passengers, and 9 deaths from cholera, and in the first week in May there were 78 deaths. St. Louis now became alarmed and used chloride of lime in the back yards and dirty places. On May 9th there were 24 new cases, and the steamboat America arrived with 22 deaths on board, and by May 14th there were 26 deaths in St. Louis per day. On the night of May 17th the great fire occurred which burnt 26 steamboats and many blocks of buildings, but the pestilence was only slightly checked thereby, there being 20 deaths a day for several weeks after; but on June 9th there were 37, and in the week ending June 17th, 402 deaths, or 57 per day. On June 17 the Sultana came with nearly 400 more immigrants, 25 deaths, and 6 bodies on board. For the week ending June 24 there were 601 deaths, or 86 per day. On the 25th a mass meeting was held, and the mayor, common council and health officers deposed, and ward committees of public health appointed with absolute powers. Block inspectors were selected for each block of houses, and some of the best and wealthiest citizens served upon them without pay. All disobedience of orders was punished by fines of $500 or less and imprisonment. School-houses were seized for hospitals, and district physicians appointed. The city was thoroughly cleansed and the streets and yards by the block inspectors. Coal, sulphur and tar were burnt in every street, and a day of fasting and prayer ordained. But the committee of safety continued to work without regard to the day of fasting, and determined to fast from cholera and not from food or work, and took that day to establish a quarantine and stop all infected boats, which they did; and also kept the fires going and the sulphur and tar smoke, which filled the whole city. In spite of all this, on July 10th the deaths reached 184, but then the pestilence rapidly declined, and on July 31st there were only three deaths from cholera. The committee had only spent $16,000 out of an appropriation of $50,000, so generous and earnest were the citizens. The total mortality was 4,555.

St. Louis depended entirely upon surface wells for drinking water, and had numberless outdoor privy pits, which contaminated them. If tar or carbolic acid could have been thrown into the worst wells, and the privies could have been thoroughly disinfected with sulphuric acid, the epidemic would have soon been over. Burning tar, sulphur and coal to purify the air, when the disease was in the wells and privies, would be amusing at the present day, if it had not been done lately in Toulon and Marseilles.

During the next year, 1850, there were deaths from cholera in every month, the total being 883, of which 458 occurred in July. In 1851, there were 845 deaths, of which 505 happened in June. February, October and December were the only months exempt. In 1852 there were deaths again in every month; the total for the year being 802. During these four years no less than 6,847 persons had died of cholera in St. Louis.

In 1853 the pestilence was wholly absent for the first time since 1848; but in 1854 it appeared again with renewed vigor, and killed 1,534 persons. Then it died out till 1866.

The great dispute has always been how the cholera came from Havre in 1848 to New York and New Orleans, while Havre gave clean bills of health. It was common then for German emigrants to go from Hamburg and Bremen to Havre to ship for the United States, and it is possible that there was no cholera at Havre except among them, which was not counted. It broke out in Paris in March, 1849, which is about the time it takes to come from Havre. It always prevails slightly for several weeks or months until the cases can no longer be concealed from their numbers. By the end of June, 1849, Paris had had 33,274 cases and 15,667 deaths, when it gradually declined and ceased altogether in October. It reached Marseilles from Paris in August, and soon after Toulon, from whence it was carried east to Nice, Genoa, Leghorn and Naples, just as it had been in 1834. It killed 53,293 persons in England in 1849; and out of 119 places, in no less than 73 it was distinctly traced to new arrivals. In others it was impossible to trace its importation, as all the diarrhœal cases were overlooked, and soiled clothing was not thought of.

CHAPTER VI.

CHOLERA IN INDIA, ASIA, EUROPE, AND THE UNITED STATES, FROM 1848 TO 1854.

WHILE cholera was progressing and staying in Europe and the United States it was again coming up from India. In 1847 Hindostan was comparatively free. In 1848 there was a great deal, especially at Juggernaut. In 1849 it had progressed to the northwest provinces, and also over to Bombay, although rain fell at the rate of 1¾ inches a day and a southwest monsoon was blowing at an average pressure of 3½ to 5 lbs. per square foot and pushing along at the rate of twenty-five miles an hour against the advancing cholera.

It was very prevalent in 1850. Thus there were only 69 deaths in Bombay in 1848; 2,269 in 1849, 4,729 in 1850; 4,020 in 1851; 1,555 in 1852, and 1,339 in 1853. In 1851 it got out from Bombay into the Persian Gulf, arrived at Bassorah June 10th, committing great ravages, and went up the river Tigris to Bagdad by Sept. 18th, killing 1,847 persons in fifty days and then disappearing Nov. 17. This epidemic was connected with the great Persian pilgrimages to Kerbela, and Meschid Hossein and Meschid Ali, just below Bagdad.

From W. A. Shephard's book, "From Bombay to Bassorah," we learn that the latter city has many pilgrim boats which are always crowded with the living and dead, going up to Kerbela and the two Meschids. The living cargoes of men, women and children are huddled together like pigs, from 100 to 150 being crowded into a space of 40 feet by 20, with 25 or more dead bodies piled about, which is rather close packing in the warm months. As these pilgrim boats went to windward, the scent was anything but pleasant, and it was difficult to say whether the living or dead were most disagreeably fragrant. Then the Arabs, living along the shores, not only stop the boats and rob the living, but also seize the dead bodies and hold them in pawn until the ransom set upon them is paid by the sorrowing relatives, who believe that the souls of their defunct friends will never reach Paradise unless their bodies are buried at the tomb of Hossein and Ali, or at Kerbela.

Dr. Boutolette says, in 1849 to 1850 there passed near Kerbela no less than 52,053 pilgrims with 64,138 beasts of burden, 4,504 muleteers and 2,837 loads of human corpses, which with three to a load made no less than 5,674 dead human bodies going to Kerbela, or Nedjed, near Bagdad.

From Bagdad cholera passed up the old route to Tabreez, killing 12,000 people, and up between the Black and Caspian seas to southern Russia, and from thence to northern Europe, Denmark, Norway, and in 1853 to numerous towns in north Prussia and Holland, and soon was in London and Newcastle.

In short, in 1851, 1852 and 1853, cholera again was brought to Europe, especially Russia, Germany, Holland, Belgium, France, Sweden, Norway, England, etc. From July to December, 1853, London had 1,265 cases; Liverpool and Manchester were severely attacked; Copenhagen had 7,200 cases; France had 125,725 deaths in fourteen months. Spain and Italy were also involved; Genoa had 5,318 cases; Sardinia 45,000, Naples 12,600, Messina 20,000. Munich had a long epidemic lasting from July through the whole winter to the next April, with 4,800 cases.

It is also a matter of doubt if the United States was entirely free from 1848 to 1854. Chicago had 630 deaths in 1852. It also persisted in St. Louis and various other places. Early in 1854 no less than 28 infected vessels sailed for the United States from England, Holland, France, Hamburg and Bremen with 1,141 deaths on their voyages; but it was not in New York, or even at the Staten Island quarantine that the disease first showed itself. The initial New York case dates June 14th, 1854. It is well known that cholera ships arrived in New Orleans in the last months of 1853 and early in 1854; but no epidemic arose till May, when 200 died in one week. It remained until its records were lost in those of the yellow fever of that year. It was at Memphis, from New Orleans, by June 3d, at Nashville, June 20. But long before this, it had been sent up from New Orleans directly to St. Louis. In December, 1853, there were a few cases. But in January and February, 1854, when crowds of emigrants began to pour into the city, the epidemic commenced and persisted during the year, being most severe in April and June, and St. Louis again suffered more heavily than any city in the United States, losing 3,547 cases. The emigrants from New Orleans were again loaded at once on river steamboats without stopping in the city, and thus the pestilence went up to the head waters of the Mississippi, Missouri and Ohio rivers. In April it commenced in Chicago and lasted through November, with 1,404 deaths. On May 19th it was at Detroit, either from St. Louis, Chicago or New York, or all three. In June it was at Ann Arbor, Michigan, with two cases from Chicago and two from New York.

Dr. Alonzo Clark puts more blame than this upon New York, and perhaps justly. Cholera ships arrived there in November, and forwarded almost all their passengers west, and he thinks they carried the disease in their baggage. On May 16th the North America came from Liverpool with 768 passengers and 17 deaths; and 120 more were attacked at the Staten Island quarantine with 70 deaths. Then came the Progress, from Liverpool, May 18, with 715 passengers and 44 deaths. Next the Charles Crocker with 414 emigrants, June 3d, and 36 deaths.

As before stated, the first death reported in 1854 in New York city was June 14th, and as early as June 2 it was at Buffalo, most probably from New Orleans and St. Louis. July 18 it was at the Suspension Bridge, Niagara Falls. By June 17 it was sent from New York to Philadelphia. Canada also competed with New York and New Orleans. The Glenmanna came to Quebec, from Liverpool, June 15, after having thrown forty-five dead of cholera overboard. It soon became epidemic.

The Niagara Falls outbreak is very interesting. The disease was at Buffalo and Detroit, west of Niagara, first; whether from New Orleans and St. Louis or from New York or Canada no one knows. From Buffalo it was sent to Niagara Falls, where the Suspension Bridge was being built and many laborers were encamped on low marshy ground, with the usual carelessness about privy pits and still more recklessness about water supply. A so-called sulphur spring was discovered, and the great bridge builder, Mr. Roebling, had a marble basin made for it. When the bridge was finished, the laborers gone away, and the open privy pits abandoned, the so-called sulphur water ceased to flow, and only ordinary, not very sulphurous, spring or low-ground water is now to be found, although the monumental stone basin is still in place. An inscription to cholera might now well be put upon it, as the outbreak at Niagara was tremendous.

In 1854 cholera was also carried east from France, especially Marseilles and Toulon, to the Crimea, where it affected the Turkish, English and French armies, and was carried down through Asia Minor toward Persia and India.

CHAPTER VII.

THE EPIDEMIC WHICH REACHED THE UNITED STATES IN 1866.

All the previous outbreaks in Europe had commenced in southern Russia, traveling up from Persia and Asia Minor, then swept westward toward Germany, been brought from thence to England, Ireland and France, and from thence forwarded to the United States.

In 1865, for the first time in many years, the great twelve-year festivals in Hindostan preceded the Mecca pilgrimages, which vary by twenty-nine days each year, as the Mohammedan is a short year of twelve lunar months of twenty-eight days each, or 336 days in all. There was a great prevalence of cholera in the Bombay Presidency with 84,000 deaths, commencing as early as March, 1865, and from there it was carried over to Mecca in April and May, when 30,000 pilgrims died. By May 23 it was at Suez, brought by steamships, which now carry many pilgrims, and forwarded to Alexandria by railroad on June 1st. It reached Marseilles on June 11th by steamships carrying Algerine pilgrims, and from thence up to Paris, with a few deaths in July, August and September, but with 4,466 in October, 1,218 in November, and 768 in December. From Paris it soon reached Havre, which concealed its epidemic, and on October 12th gave the Atalanta, with 604 passengers, a clean bill of health; but she had 102 cases and 23 deaths before she reached New York. The Hermann arrived with seven deaths on November 16. Up to Dec. 30, 1865, thirty-six vessels from cholera ports arrived at New York, and by November 22 it broke out in the emigrant hospital on Ward's Island; but owing to the coldness of the weather the pestilence did not extend.

According to Dr. Ely McClellan, the outbreak in North America commenced with the steamship England from Liverpool, March 28, 1866, with 1,185 emigrants, 160 cases, and 46 deaths before she reached Halifax. Then followed the Virginia from Liverpool, arriving at New York, April 18, 1866, with 1,029 steerage passengers, 38 deaths, and 46 sick on arrival. From that time to Nov. 28, cholera ships arrived at New York, with 8,491 passengers and crew, and 172 deaths, or 10 per cent. from cholera; six of the vessels were from Liverpool, five from Hamburg, one from Bremen, one from Antwerp, two from London, and two from Havre; all of which places were more or less infected. On the Liverpool ships there had been 492 deaths; on the Hamburg 96; on the Havre 113; on the Bremen 12; on the Antwerp 18; on the London 1.

France had so often received the cholera from Germany that she returned the compliment for once this year and infected Holland, Belgium, Hamburg and Bremen. Many of the Liverpool steamships touched at Havre, and filled up with infected persons and clothes. Besides, cholera had been landed at Southampton, England, as early as June, July, August and September, 1865, by steamships from Alexandria and Egypt.

The first death in New York city in 1866 was May 2, at a tenement house far up town in 93d street, near Third avenue, possibly brought over from Ward's Island; the second on the same day in Mulberry street; the third at 303 Broome street, near Forsyth; the fourth washed the soiled clothing of the third; the fifth was in a tenement house in West 20th street; the sixth in Hester street; the seventh near Pitt and Willett streets; the eighth on Cherry street; the ninth near Greenwich and Liberty streets. No connection could be traced by the late Dr. Elisha Harris between these cases, except the third and fourth; but 2,094 persons from infected ships had already been let loose in the city. None of the first deaths were emigrants; no account had been or could be kept of the non-fatal cases. The seeds of the disease had been sown by the soiled clothing of the emigrants, or by the diarrhœal discharges of those who recovered. These are the only solutions of this curious problem. The germs of the disease had been undoubtedly imported, and affected disposed or susceptible persons in the seemingly mysterious way that cholera always attacks large cities. Up to July 8 there were only 21 deaths from cholera in New York, none of the victims of which were emigrants, but merely persons who resided in localities frequented by freshly landed emigrants. The first case in Brooklyn was in the first week of July in a quarter entirely inhabited by foreigners, and established an intense local epidemic.

July 14 it became epidemic again in the emigrant hospital on Ward's Island. July 3 the first fatal case happened among the garrison of Fort Columbus, on Governor's Island, the then general recruiting depot of the United States army, and from this last center the disease was extensively diffused over the whole country. The first case was a recruit who came from Minneapolis, Minnesota, 1,000 miles and more away, who spent three days in New York before going to Governor's Island. From Governor's Island it was sent by troops to Hart's Island in Long Island sound; to Tybee Island, Georgia; to Louisiana by way of New Orleans; to Texas via Galveston; to Louisville, Kentucky, overland; to Richmond, Virginia; to Nicaragua bay; to Norfolk, Va.; to Bowling Green, Kentucky. The next principal army center of cholera was Newport Barracks, Kentucky, probably derived from Cincinnati; and from there it was sent to Augusta and Atlanta, Georgia, and to Nashville and Memphis, Tennessee. If cholera can cling so long to, travel so far with, and ravage so extensively such a fine body of troops as compose the United States army, when cared for by such capable army surgeons, what are the chances of the conveyance of the disease by large bodies of dirty emigrants with little medical attendance at sea and not much more on land?

As New York must bear the brunt and odium of having introduced cholera into the United States in 1866, and as that epidemic was particularly well studied by my late lamented friend, Dr. Elisha Harris, while it offered all the problems, solved and unsolved, which may and must puzzle doctors and sanitarians in small as well as in large towns and cities, I will devote fair space to it. The equally lamented sanitary superintendant, Dr. Edward R. Dalton, took control of every house which cholera entered. A daily marked map of every case of severe diarrhœa and choleraic disease was kept: over 50 telegraph stations were connected with the health office, and 2,000 policemen in addition to the sanitary corps aided in giving the earliest information of every suspicious and dangerous case.

Distribution of the First 25 Fatal Cases of Cholera in New York City in 1866.

Dr. Elisha Harris says:

> "Previous to July 8th, 21 cases of well-marked cholera had terminated fatally. They occurred in 17 different streets, in 18 different blocks and in 19 different houses. There were two houses in which second fatal cases occurred within three days of the first case. There were two groups, each having three fatal cases within 200 yards of each other. The two groups of two cases each in a single family and house were at 303 Broome street, 100 yards east of the Bowery, and at 19 Mulberry street, 80 yards north of Chatham. The two city groups of 300 deaths, with but a few days' interval between the seizures, were the first in Cherry and Oak near Roosevelt streets; the second in Mulberry and Baxter, near Chatham street.
>
> "The residences of the 21 fatal cases together, with 10 other non-fatal cases, were widely scattered over the city, and none of the 31 were discovered to have been in any way directly (!) exposed to persons or things from the quarantine or from the emigrant landing or depot. Yet every one resided in or frequented localities that were daily traversed by freshly landed emigrants; still no foul beds or clothing, or previous choleraic diarrhœa, those good and sufficient causes of infection, which were both suspected and expected, were to be found at this late date of investigation. The city is too densely crowded, and the mixing of the population is too promiscuous and utterly unnoticed and unregistered, to warrant any attempt to trace the connection of events and acts that may have occurred daily in the places where the cholera poison was received into the system."

The Atlanta had arrived from Havre in Nov. 1865, with cholera on board, about six months before the first case declared itself in New York on May 1st, or the near beginning of warm weather. Germs may have wintered over in strange places. The first case was in East 93d street, nearly opposite Ward's Island, where, in the fall of 1865, 29 persons had died of cholera and were buried. The privy was on an open lot and visited by tramps and persons coming to and from Blackwell's Island. The Virginia arrived from Liverpool April 18th, with 31 cholera deaths and 66 more at quarantine; and the England, April 20th, with 267 deaths, and new germs had been brought by 2,477 emigrant passengers. And this number was increased by the Peruvian with 488 passengers and 66 deaths May 30th, or six weeks before the outbreak on Blackwell's Island. The first death was on Ward's Island after November 1865; 27 deaths were on July 21, 1866; the average population, including 50 laborers with 13 cases and deaths from the Blackwell's Island workhouse was 900, with 172 deaths. Potter's field is on Ward's Island, and a great proportion of the poor who died of cholera in New York city were buried there in rough coffins and shallow trenches. The State's Emigrant Refuge and Hospital were sadly ravaged with cholera.

These great possibilities and probabilities would have amounted to certainties if a more accurate account of all the arrivals of infectious diarrhœa at Ward's and Blackwell's islands and New York city could have been kept. Now McGowan's case July 9th, Hatton's July 20th, Conroy's July 22d, Mary Tracy's July 21st and 23d, and three others on July 25th and 26th, are sufficient to account for the great outbreak on Blackwell's Island on the night of July 26th and 27th, 1866.

To return to New York: July 8th there were three fatal cases of cholera in characteristically foul localities more than half a mile distant from each other; one was in Cherry street near Roosevelt; one in Charlton near Varick, and one in Delancey near Pitt street. On the 9th, 10th and 11th there were four fatal and two non-fatal cases, one of them in a new locality, the great shanty block west of Central Park, of which more anon.

July 15, four fatal cases in the old spots, and July 18th two deaths in a tenement house 120 feet distant from a previous case six days before in Chrystie street.

In the first twenty days of July there were only 36 deaths in New York and one each on Governor's and Ward's islands, while Brooklyn had 32 fatal cases. Total for July, 110 fatal cases in New York and its institutions, and 100 in Brooklyn; so slowly did the epidemic crop up, as it always does when there is no water poisoning. Of numberless other cases which recovered, only 22 were decided to be well-marked cholera. The excessive heat of the greater part of July caused an alarming mortality among children from cholera infantum; no less than 17 per day for the first week; 37 daily the second week; 65 the third; and 50 a day during the fourth week. Brooklyn was affected in the same ratio.

Summer cholera or diarrhœa is caused not so much by mere heat, as by foul heat, which corrupts so much food, vegetables, meats and milk, besides debilitating the body and perhaps causing vaso-motor paralysis of the intestinal mucous membrane, making it exhale as much fluid as pours from the relaxed skin in the perspiration of hot close weather. It is a largely septic diarrhœa which green, unripe or spoiled fruits and vegetables, and even meats and fish, materially aid; and which checked perspiration may materially increase.

Diarrhœal centers or fields were established in New York by the weather in crowded and filthy streets, houses, alleys and courts, where the gutters were foul and the open privies horrible. There was but little diarrhœal mortality in the best and cleanest parts of the city, partly because this population, with their children, always go to the country in hot weather. The diarrhœal fields, were thought to be most common on the beds of former swamp lands, underground stream beds, and natural subsoil water basins that are undrained to this day. Still there were some notable exceptions in shanty towns on high rocks and slaughter-house districts on rocks without sewers or other good drainage.

But the disease was not in the air, for in the midst of the most fatal and most persistent diarrhœal centers the clean and well kept mission houses with crowded populations of the poor but well fed and well washed children escaped not only cholera, but diarrhœas of any and every kind. Thus the Five Points House of Industry, 155 Worth street, had an unpaved street in front of it, damp and greatly soiled by the dirty neighbors with garbage. Also buildings in the rear and opposite, occupied by the most filthy and degraded beings in the city, and among which cholera raged; yet out of 200 inmates there were only twelve cases of diarrhœa and one death. The diet will also puzzle some choleraphobists; bean soup and vegetable soup, each twice a week, with plenty of beef and mutton boiled in them. Four meals a week of stews and hash. Indian pudding, hominy, mixed wheat, rye and Indian bread with butter, and fruits when obtainable. There was no cholera because none was admitted into the house.

The average number of deaths from diarrhœal and choleraic disease for eleven years from 1854 to 1866 was 2,567 per year; viz., from cholera and cholera morbus; in 1854, 2,810; 1855, 58; 1856, 56; 1857, 53; 1858, 56; 1859, 71; 1860, 97; 1861, 85; 1862, 93; 1863, 191; 1864, 85; 1865, 98; 1866, 1435.

The deaths from acute diarrhœa, dysentery and cholera infantum during the same years were: 1854, 2,592; 1855, 2,484; 1856, 2,302; 1857, 2,179; 1858, 2,521; 1859, 2,124; 1860, 1,788; 1861, 1,896; 1862, 1,935;

1863, 2,550; 1864, 2,488; 1865, 2,738; 1866, 3,524. As there was no appreciable increase of mortality from these diseases in the great cholera year of 1854, it is possible that the 1,200 more in 1866 may be attributable not to common cholera but to Asiatic cholera, and New York may have had 1,200 more deaths from cholera in 1866 than she has previously admitted.

Dr. Harris says: "The occurrence of 1,212 fatal cases of Asiatic cholera, together with an acknowledged excess of some 2,489 fatal diarrhœal maladies over and above the usual mortality should be fully explained." Perhaps some of the numberless cholera cases reported by physicians and rejected as such may contain the explanation. Many old and weakly persons die of cholera before the previous contents of the bowels are fully evacuated and rice-water discharges appear. Many of the consecutive cases of cholera assume the form of dysentery or at least have bloody discharges. The consecutive, or typhoid, or so-called uræmic fevers of cholera are reported as fevers. Many rapid cases of so-called cholera infantum are cases of true cholera. If all these be excluded and a diagnosis based solely on rice-water discharges be insisted upon, the rate of deaths from Asiatic cholera can easily be largely reduced, and apparently justly.

Dr. Harris puts the matter as plainly as he can when he tells us that in the week ending June 9th there were 2 deaths from cholera; 16th, 6; 23d, 4; 30th, 1; or only 13 in all. July 7th, 3 deaths; 14th, 11; 21st, 11; 28th, 48; or 73 in all, or only 86 in two months, so slowly did cholera increase. If only the acknowledged cases were stamped out and disinfected, many others must have escaped sanitary care.

In August the explosion came, with 239 cases the first week; 258 the second; 145 the third; 114 the fourth; so that the work of the health authorities was beginning to tell, or the epidemic to decline. In September, first week, there were 50 fatal cases; second week, 50; third week, 67; fourth week, 54; fifth week, 38. In October, first week, 36; second, 12; third, 5; fourth, 3. In November, first week, 5 deaths; second, none; third, 1; fourth, 1; when the epidemic ceased.

In the same weeks there were of cholera infantum, June, first week, 1; second, 6; third, 13; fourth, 40; July, first week, 61; second, 172; third, 278; fourth, 176. August, first week, 144; second, 133; third, 108; fourth, 122. There is evidently no concealment or exaggeration to be found here. September, first week, 79; second, 69; third, 51; fourth 55; fifth, 42. October, first week, 27, and so on diminishing.

Cholera in Brooklyn in 1866.

Dr. Conklin makes the report for Brooklyn thus:

> "In June and the early part of July, cases simulating cholera occurred, but the first reported cases happened July 8th. Its increase at first was not rapid and mostly confined to places where there was the greatest amount of filth, especially in the southwest 12th Ward, which had many depressed lots and ponds of foul, stagnant water. Some of the houses were built on piles in sunken places, filled with garbage and other foul stuff. There were no sewers. In this ward 288 cases out of 816, or more than one-third, occurred.
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> "In the week ending July 13 there were 14 cases; July 20, 42; July 27, 53; Aug. 3, 83; Aug. 10, 161; Aug. 17, 132; Aug. 24, 80; Aug. 31, 47; Sept. 7, 81; Sept. 14, 28; Sept. 21, 44; Sept. 28, 25; Oct. 5, 5; Oct. 12, 5; Oct. 19, 12; Oct. 26, 3; five more days, 1. Total, 816. In the Hamilton Avenue hospital, Dr. Thayer had thirteen cases in the first stages, of which twelve recovered; fifty-seven in the second, with fifty deaths; seven in the third, all of which died; showing the advan-

tage of early treatment. Singularly enough the cases in infants whose mothers died of cholera, were reported as cholera infantum.

"The average duration of cases fatal in the second stage was thirty-one hours; shortest, eight hours; longest, seventy-five hours. The average of the third stage fatal cases was nine days; shortest, five days; longest, twenty days. In these, cases of consecutive fever were included.

"In the Brooklyn City Park Hospital there were eighteen cases and eleven deaths, mostly admitted in collapse. The main treatment was calomel, ten grains at first dose, then one grain every hour; green tea and brandy. For bloody discharges, injections of laudanum and gum water. The effect was good. After reaction, beef tea and stimulants, with teaspoonful doses of paregoric, which were generally sufficient to control subsequent looseness of the bowels.

"In the county jail there were thirty-six cases in a short time after July 31st. It was stamped out in thirteen days by moving the patients to tents, change of diet and disinfection. The first case was May 22d, possibly merely septic cholera, in a man digging a trench soaked with excrements. The second case was July 21st, or two months after; the third on the 24th, and then every day there were a few cases until Aug. 2d, when there were no new cases for one day; but on the night of Aug. 3d, no less than thirty-eight cases of the most malignant character occurred, with twenty-two deaths in twenty-four hours. The building was vacated, and fifty prisoners for slight offenses were discharged. No treatment seemed of any avail. In all there were eighty-seven cases and sixty-seven deaths. The initial case was not discovered, but the outbreak was possibly due to imperfection in the water pipes, which were laid in the trench soiled with excrements, on May 22d. There were fifty-five deaths from so-called cholera morbus in July, seventy-two in August, fifteen in September; total, one hundred and forty-two, which is unprecedented. Outside of the Twelfth and Sixth Wards, the mortality was insignificant, except the sudden and overwhelming outbreak in the penitentiary in the Ninth Ward. This building is on the summit of a hill; the drainage, ventilation and cleanliness unexceptionable. But at the foot of the hill are large stagnant pools, cow stables, and pig yards. On the night of the outbreak the air was hot and damp, with scarcely breeze enough to move away the poisonous vapors which overflowed the plain and permeated the penitentiary. There was no Asiatic cholera in Brooklyn in June, but thirty-three deaths from cholera infantum, and thirty-eight deaths from acute diarrhœa, dysentery and cholera morbus in adults. The first cases in the penitentiary were on July 21st and 24th; then none till the night of Aug. 3d, when there were thirty-eight severe cases, nearly fourteen per cent. of the inmates, four-sevenths of whom died, or eight per cent. of the whole residents. Five assistant keepers and one nurse were also attacked. The importation was not traced, except that in the Raymond street jail nearly one-half of the inmates were destroyed, and that the penitentiary was supplied every week with new inmates directly from this jail."

No one has yet ever positively puzzled out the initial cases in New York, Brooklyn or Blackwell's Island. They were detected at once on Governor's Island by the military surgeons. There was abundance of opportunities for importation in all these places; and importation doubtless did take place, but in large cities and institutions the non-fatal diarrhœal cases necessarily do not attract much attention; probably not a tithe of them run on to fully developed cholera; still more are cured by early treatment; but they are all infective. The unwashed hands of the diarrhœal cases are probably the first agents in the conveyance of the disease; next the vomits which are apt to go over bed and body clothes, and on floors. The towels and basins come next. Then the discharges, which go into privies and the soakage from them into wells of drinking water. Bread, cake, fruit, and vegetables handled by persons with incipient diarrhœa are great agents in the distribution of the disease, and however good or ripe these articles may be, they are more dangerous than uncontaminated green apples, cucumbers, soft crabs and lobsters, to say nothing of water-melons, which are doubtless as harmless as eggs, as the soiled rinds are never eaten.

CHAPTER VIII.

THE CHOLERA WHICH REACHED THE UNITED STATES IN 1873.

THE great Bombay and Mecca cholera of 1865 still lingered in Persia in 1867, especially in Teheran, the capital, near the foot of the Caspian sea. This was early in the summer. The outbreak was probably a reappearance of the epidemic of the previous year. In 1867 the great twelfth-year Juggernaut epidemic of 1865 was supplemented by the Hurdwar outbreak, in which three millions of pilgrims were involved in the extreme north of India, and was carried through the Bolan pass, went into Afghanistan and also through the Kyber pass to Cabul. The pestilence raged with almost unprecedented violence in Afghanistan early in July, 1867, and appeared in numerous places along the road from Herat to Meschid and Teheran; and was even on its old march up between the Black and Caspian seas. I have already alluded to Hurdwar and this route, but it is necessary now to dwell upon them more fully.

Cabul is the first great town to the northwest over the borders of the British possessions in India. It is the grand center of the trade of India with Persia, Central Asia, and Russia. It is the southern terminus of the Russian commerce with Hindostan, and has long been the theater of the commercial and political rivalry of Russia and England, in their attempts to control Persia and Central Asia. Cholera is regularly brought up to Cabul from Hurdwar, through Lahore, Attock, and Peshawur, and, although it is called "the city of 100,000 gardens," parts of it are well adapted to multiply the infection of cholera. Many of its small streets are built over, forming low, dark tunnels, containing every offensive thing. Water collects and stagnates in ponds all over the city; the inhabitants cast out the refuse of their houses into the streets; and dead dogs and cats are frequently seen lying on heaps of the vilest filth, while dead horses occasionally pollute the air for many days together.—Sir Arthur Connolly.

The traffic between Russia, Persia, Central Asia and India, by way of Cabul, is made under curious conditions, which have descended from high antiquity; for it belongs to four tribes of Lohanee Afghans, called *Provindahs*, who are both pastoral and mercantile in their pursuits, and number 8,000 families, with over 30,000 camels and 10,000 oxen of transport. They organize themselves into three immense caravans, which resemble veritable *corps d'armée*, and descend into India, not only in time to attend the great fair at Hurdwar, but also to penetrate down the Ganges to Benares, and along the Indus to Kurrachee, and thence by sea to Bombay. They bring down Russian, Persian and Afghanistan articles of trade, and return with cotton goods, muslins, shawls, silks, brocades and innumerable other articles. The first great division has 20,000 to 30,000 camels, numerous oxen, and 50,000 to 60,000 head of sheep; the second division, 10,000 to 17,000 camels and a proportionate number of oxen and sheep; and the third division, 3,000 to 5,000 camels. These all return to Cabul and Candahar by the middle of June, in time to dispatch their investments on to Herat and Meschid in the west, and to Balk and Bokhara in the northwest. They also always descend again into India by the end of October, with 36 different Russian articles, and return with 64 kinds of English and India goods. From 1,500 to 2,000 camels are alone employed in conveying pomegranate rinds, which dress leather in a superior manner; 3,000 camels carry coarse cotton cloths from India to Cabul; five caravans with shawls, from the 16,000 looms in Cashmere, have arrived in Cabul in one year; much salt is carried up from the inexhaustible mines at Lahore; many thousand camel-loads of fresh and dried fruits are brought down to India; and Russian goods are so cheap and common in Cabul, at times, that looking-glasses large enough to serve as window-panes are sold for half a dollar. In addition, there is a great Hindoo festival on the banks of the Indus, near Attock, every April, to which great crowds congregate. Pilgrims also come down from Cabul to the river Indus, which they descend to the sea and then pass on to Mecca; and a great Mohammedan festival takes place on the 28th of March. Such are the causes which propel cholera up from India to Candahar and Cabul.—Sir Alex. Burnes.

From Cabul, the disease is always carried due west to Herat. Occasionally, it has happened that a single traveler or pilgrim could proceed, unarmed, from Cabul to Herat. But, generally, the merchants and devotees travel in great caravans, with long strings of camels. They are armed to the teeth, and often bear the marks of many a conflict. Now and then some prince, like the son of the King of Lucknow, comes up with a large suite of Indo-Mohammedans; and it is thought that over 60,000 pilgrims pass through Herat every year, on their way west to the holy city of Meschid.

Herat has at least 50,000 inhabitants, and is a well known town; but in 1857, the *London Times* asked, "Where is Herat?" It is in the extreme northwestern corner of Afghanistan, and stands in the same relation to this province that Peshawur does to India; for it is the only gate by which it can be approached from the west. All the practicable roads from Persia and Central Asia converge and unite as they approach Herat. It is the door and citadel which must be opened before caravans and armies from Persia and the west can reach Afghanistan and Hindostan. Its situation is one of the greatest military and commercial importance; for the peaceful files of the caravan and the dread battalions of war must alike pass through it on their way from India to Persia, and from Persia to India. Long camel trains, coming up from Delhi, Moultan, Hurdwar, and Lahore, traverse it, bearing the products of India and the manufactures of England to the distant towns and oases of Persia and Turkestan. So completely is Herat a gateway of commerce, that is called a "*bunder*," or port, although the only seas upon which it borders are seas of sand. The march of conquest has led through it from time immemorial, especially after the time of Mohammed. Since A.D. 710, host after host of fierce warriors, led by the Kaliphs of Damascus and Bagdad, of Syria and western Persia, coming almost from the borders of the Caspian, Black and Mediterranean seas, have carried the tassels of the Mohammedan flag victoriously down into India. The vast and fertile plain about Herat has often been a huge *place d'armes*, where all the assembled columns from the west have united and recruited before making their final descent upon Hindostan, and *it has often been predicted that the Cossack and the Sepoy must sooner or later meet there in deadly strife*. No better camping-ground and quarters have ever been found for caravans and armies. Abundant crops of wheat and barley, and every kind of fruit known to Persia, grow there in profusion. Cattle and sheep abound. The bright waters of the river are as "clear as tears," and numerous running streams and artificial canals light up the pleasant landscape and fertilize the soil. Such is the profusion of roses, that it is called the "*City of Roses*," and a very large proportion of the whole world's supply of the celebrated "Attar" comes from it. But there are other smells than those from roses about Herat. At night, on the road, one is apt to be awakened by the shouts of drivers and the tinkling of bells, announcing a passing caravan, and by the faint light of the moon perceives a sea of long, black boxes surging by on scores of mules and camels. Each animal is laden with two of these horrible objects, one on each side, and many of them are so loosely nailed together that another sense than that of smell soon convinces one that they are used as coffins. In fact, they contain the bodies of the devout, who, having died in the true faith, are now being taken to be buried in holy ground at Kerbela or Meschid. They are often carried hundreds of miles, and a sickening stench always comes up from their gaping fissures, causing nausea and faintness in the drowsy, unsuspecting traveler, who finds it impossible to extricate himself promptly from their neighborhood; for they come crowding on in the dark as if there were no limit to their numbers.

The cholera of 1828 swept away many thousands in Herat, although water, that prime necessity of Oriental life, is so abundant that almost every house has its fountain, besides the large public ones in the streets and bazaars. Each successive epidemic of the disease in Hindostan has reached Herat, and been carried on through Persia to Turkey and Russia. That of 1841 reached Cabul in June; Herat in August; Meschid in September; and Teheran in October.

The next important town due west of Herat is Meschid. This is so holy that no person of any sect called Mohammedan has ever dared to commit the impiety of firing a hostile shot at its walls. For eight months in the year all the roads to and from Meschid are thronged with pilgrims. Nearly 60,000 come up from India, Cabul and Afghanistan; and as many more from the south of Persia. Over 100,000 crowd on fanatically from Turkey in Asia and the Caucasus in the west; and perhaps an equal number from the north.

Connolly says the distant cities in which the pilgrims assemble and make themselves up into caravans, to go to Meschid, are so thronged with men and animals that there is scarcely passage through the crowd. Horses, mules, camels, and cattle are picketed the entire length of the outer walls, where they neigh, bray and fight, while their masters are busy currying or shoeing them; mending pack-saddles; higgling for supplies of straw or corn; or sleeping, praying, or reading the Koran.

The pilgrims generally travel at night; some of them carry torches, and at the head of the line a pot of live charcoal swings under the belly of a horse, to light their pipes and mark the line of march. In cool and pleasant weather they move by day. Gay pennons are then unfurled, and all go on with light hearts. From time to time, their leaders raise a shout for the blessed Mohammed, and if their followers do not join in loudly and unanimously, they are urged to do "better than that," "sweeter than that," angels are called upon to aid them, till finally the air is rent with fervent and inspiring cries, which makes one's very heart's blood boil. Going and returning pilgrims greet each other on the road. Many others are seen encamped at the roadside; the poorer pilgrims in miserable tents and shelters, but the richer Turks and Persians in green, sky-blue or white tents, surmounted by gilt balls and crescents, and lined with costly carpets. Well-clad male and female servants, in numberless groups, walk, recline, sit, smoke or chat in and about the camps. Hundreds of horses, richly caparisoned graze around. Huge piles of baggage and provisions are guarded by trusty soldiers, bristling to their chins with silver-hilted daggers and inlaid pistols, the whole bearing an air of wealth, pomp, and security.

The scene is more wild and strange when the pilgrims halt at caravansaries. The noise and quarreling, at first, can only be imagined by those who have seen Persians on the march. But the leader of the caravan soon takes his place in the middle of the square, and commences reciting prayers and verses in honor of the Prophet, to which the pilgrims shout short sentences from the Koran in reply. Connolly says the effect of their voices coming from the cells on all sides is very wild and pleasing, especially at night, when the sounds gradually rise, chiming in with each other till they are perfectly blended in one full chorus. But soon all fall asleep and silence reigns in cells which are so filthy that few Europeans can remain in them.

Finally, the holy city is reached, and several times in the course of every day dense troops of soiled and jaded pilgrims and travelers pass through the city gates of Meschid, into the great square, which is usually crowded with people from all parts of the East; with Afghans, Arabs, Koords, Turks, Osbegs; with pilgrims from all the provinces of Persia; with priests, merchants, peasants and dervishes, without number, from the borders of the Caspian and Black seas, and from the Persian gulf. The great and magnificent square is approached from two sides by very high arched gates, of exquisite architecture, faced with brilliant blue-enameled tiles. On the other two sides are deep arched porches, of the same height and proportions as the gates, but covered with copper tiles, heavily gilt. One porch leads into a fine mosque; the other faces a high, gilded minaret, and the golden dome under which rest the sacred remains of the Iman. The space between the gates and porches is inclosed on all sides by a double story of arched cloisters, fronted with mosaic work and paved with the gorgeous gravestones of rich and holy men. A stone canal conducts water through the center of the square for the ablutions of the faithful, and beautiful shade trees abound. The midday sunbeams are reflected gorgeously from the many-colored and golden tiles; and the light of the declining luminary falls glowing upon the resplendent dome. But the most glorious effect is produced when rain falls while the sun is breaking through light clouds, causing the large drops which are shed from the golden tiles to glitter like enormous diamonds. This sparkling shower on the gilt dome is often worshiped as a downpour of heavenly light, and excites the pilgrims to a perfect frenzy of enthusiasm.

But Meschid presents other sights and sounds than those of religion and pleasantness. Hundreds and thousands of beggars, of the most miserably squalid appearance, beset every approach to the shrine, waylaying the pilgrims in every direction. Old men and women, in the most abject states of want and misery, throng the streets, which are also strewn with children not more than two or three years old, grovelling in the dirt, mere living skeletons, more like starved young animals than human creatures. Some are crying and sending forth piteous petitions with their little half-quenched voices; others, silent, lying like dead things; others, listless and motionless, but with a wolf-like glare of hunger in their sunken eyes, giving terrible evidence of the fierce pangs which gnaw within them. Blear-eyed girls and filthy boys carried things like starved cats in their arms, all squalling for bread. Fraser ran the gauntlet of a crowd of specters of this kind nearly half a mile long. Most of them were the wives and children of Turcomans from the eastern borders of the Caspian Sea, whose towns had been sacked by the Meschidees. The able-bodied men and women had been sold as slaves, and the old people and children thus left to beg or starve. As many as 3,000 to 4,000 persons have been brought into Meschid at one time, and the feeble left to the tender mercies of pilgrims and strangers.

Cholera is always carried from Meschid to Astrabad, on the east coast of the Caspian sea, by merchants and pilgrims, and then forwarded up to Astrakhan. It is also conveyed from Meschid to Teheran, the capital of Persia, situated only 70 miles south of the lower border of the Caspian Sea.

Cholera had almost completely died out in Europe in 1868, especially in Russia, when suddenly in July, 1869, it was heard of at Kief, the holy city of southwestern Russia, on the river Dnieper, about 100 miles above its mouth at Odessa, on the Black sea. From June, 1869, there had been numerous cases of choleraic diarrhœa at Kief, but up to October only 69 cases of fatal algid cholera, and up to Dec. 11, only 115 cases in all. In July, August and September, 1869, it also broke out at the great fair of Nijni Novgorod, just east of Moscow, to which over 200,000 merchants assemble from all parts of Russia, Persia, Central Asia and many other places; but the pestilence was not acknowledged until after the fair had come to an end and the people had dispersed. There is doubt whether the pestilence commenced at Kief or Nijni. Cholera had previously reached Tiflis, near the pass of Dariel, and a line of railroad had been built from it in 1867 to Poti on the east coast of the Black sea, from whence steamships ran regularly to Odessa. A railroad to Kief had also just been opened, so that cholera might easily and quickly have been conveyed to Kief. But a railroad had also been built through the pass of Dariel directly up into Russia toward Moscow and Nijni, and cholera could have traveled equally rapidly that way. However this may be, there were 911 fatal cases in Russia in 1869; no less than 20,140 in 1870; and the enormous number of 305,220 in 1871.

Canals connect the river Dnieper, which runs south to the Black sea, with the rivers Niemen, Vistula and Oder, which run north to the Baltic. Over 40,000 Polish raftsmen ply these streams, and in 1871 and 1872 Poland had 37,586 cases of cholera; Galicia had 38,448; Hungary 433,295, from 1871 to 1873; Prussia 37,000. Altona near Hamburg became involved as early as August 9, 1871, and Hamburg itself by August 28, and even shipped it by the ship Alster to England in September. In August, 1872, there were 107 cases in one week in Hamburg, and there were 1,225 cases in that city in 1873. On Oct. 10, 1871, the steamship Franklin left Stettin on the Baltic and arrived at Halifax, Nov. 6, having lost 40 of her passengers, and then came on to New York. Suddenly in Feb., 1873, cholera commenced at New Orleans. The first victims were a Frenchman and German, but they were old residents. The Bremen and Hamburg steamships running to New Orleans, which touch at Havre, were suspected, but nothing could be proved. Whether the first victims received soiled goods or visitors from Europe no one knows. But the New Orleans authorities had something to conceal, as the published shipping lists will show. The Secretary of State asked for a list of the cases of sickness and deaths at sea on board the vessels arriving at New Orleans in January and February, 1873; and the subjoined was all that could be obtained; everything was given except what was asked for. Even the names of the regular steamships plying to Havre, Bremen and Hamburg were omitted. It is sufficient to say that the same quarantine officer let in the yellow fever of 1873, and was then dismissed. In January, 1873, two vessels arrived from Havre, one each from Antwerp, Leghorn, Rio Janeiro and Bristol; ten from Havana, all of which places are said to have had cholera.

In February, there were arrivals from Rio Janeiro, Genoa, Italy, Havre, Antwerp, Messina and Sicily, all of which were infected. The number of passengers on 52 vessels was not given, nor the sickness and deaths among these and the crews. There was strictest concealment; but we have already seen how difficult it is to track down the initial cases in large cities.

Epidemic Cholera in the United States in 1873.[1]

The earliest recognized case of epidemic cholera in the United States during the year 1873 occurred in the city of New Orleans, La., on February 9. It was impossible to determine any connection between this and other early cases of the epidemic and the occurrence of any imported cholera case; but many essentials of an outbreak of epidemic cholera were most positively determined. It was found that during the last month of 1872 and the first six months of 1873, three hundred and forty-two vessels arrived at New Orleans from European, West Indian and South American ports. That these vessels carried into the port of New Orleans four thousand two hundred and forty-nine passengers, the majority of whom were emigrants; and seven thousand two hundred and forty-nine officers and crew; a grand total of eleven thousand four hundred and ninety-eight individuals. The statistics of emigration showed that of the six thousand and seventy-nine emigrants received at New Orleans during 1873, only two hundred and ten were from West Indian and South American ports. The majority of emigrants were shipped at Bremen, Hamburg, Havre and Liverpool. It was further found that the quarantine upon the Mississippi river in 1873 had been worse than useless; that emigrants and their effects were passed without questions; that the majority of emigrants in New Orleans were lodged in tenement houses on the levee, and on that portion at which coast and river steamers land. It was further found that the first twenty-five fatal cases, those which occurred in the months of February and March, could one and all be traced to their daily avocations on or near the steamboat levee, and to each other. It was further found that no record of diarrhœal or non-fatal cholera cases was attempted until it was too late to obtain any information of them.

At New Orleans, the epidemic influence lasted from February to November, 1873, having a total of two hundred and fifty-nine deaths. The total number of those who were attacked by the disease can never be determined. The epidemic influence did not spread over the entire city, but was confined to the central and the oldest portions. Cholera was carried from New Orleans to nine different parishes of the State. The most active agents in this diffusion were coast, river and trading boats, as they had been in all former epidemics.

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[1] This part of the chapter is from the pen of Dr. Ely McClellan.

From New Orleans the progress of cholera, was first confined to the line of the Mississippi river. At Vicksburg, Miss., the first authentic case occurred May 12, when the epidemic was at its worst in New Orleans. It is very probable that the infection of the initial case was from river steamers. That these boats were cholera infected was shown by the fact that on May 14 the steamer John Kilgore, from New Orleans to Cincinnati, O., called at Vicksburg having on board a violent case of cholera, for whom the services of a Vicksburg physician were obtained.

Very little information could be obtained as to the epidemic on the lower Mississippi; my efforts almost always ended in failure. A modified epidemic occurred at Jackson, the capital of Mississippi. From Dr. T. I. Mitchell I obtained the interesting history of one group of cases. A negro girl, who was employed as a servant in a Jackson family, was taken with cholera and died. Her father and his family lived in the country some miles from the city. The day the girl died, the father removed all her effects, including the bed on which she died, to his home in the country. One week later the entire negro family, consisting of seven individuals, had cholera, and all died but one. Doctor J. A. Tillman reported several outbreaks of cholera upon plantations in what is known as the Deer Creek district; and includes the instance of a negro man who stole some articles of clothing from a cholera-infected house, which articles he carried home. Three days later this man, his wife and three children all had cholera. The woman alone recovered. The city of Natchez, Miss., escaped this epidemic, as it had escaped all previous epidemics. A most perfect sanitary condition was maintained. Quarantine regulations were strictly enforced. The water supply was pure.

In the State of Arkansas, the earliest cases were at Osceola on April 17. A man who had just returned from Memphis was taken with cholera in a miserable hut, which was occupied by ten other persons. The first case died in a few hours. Three other cases followed, when all were removed from the hovel, and the disease was stamped out. Sept. 8, a second outbreak occurred, which was traced to river boats, and the epidemic was confined to a few filthy negro huts. At Pine Bluff, a man living on the Arkansas river, near the steamboat landing, was taken with cholera June 25, and died the next day. June 30, his son-in-law, who lived in the same house, was taken and died in 24 hours. July 3, the wife of the last case was attacked but recovered. July 5, a man who had nursed the preceding cases died of cholera; the same day a negro servant of the last case was taken sick and died the next day.

In the city of Little Rock, four distinct importations of cholera occurred. Each were sufficient to have created an epidemic, and each would undoubtedly have been successful but for the active sanitary measures employed. June 29, a young woman from some point on the Cairo and Little Rock railroad, returned to the city and went to her home in a tenement house, where she was taken with cholera and died after an illness of twelve hours. Every precaution was taken to isolate the case, and no spread of the disease occurred. July 2, a negro deck hand from a Memphis steamer was admitted late at night to the county almshouse.

He was sick with cholera, but he was placed in a miserable hut with other negroes, and his case was not reported until early the next day, when he was found in the stage of collapse. The excreta had during the night been thrown out around the hut. At daylight Dr. Dale, being called, at once instituted the most active measures of disinfection, and was so far successful that, although eight fatal cases followed among the negroes occupying that hut, the disease did not escape to the city. July 6, a laborer on the Cairo and Little Rock railroad came into the city, went to a low tavern, where he was taken with cholera and died in twelve hours. This case was successfully isolated. July 6, a convict died of cholera at the State penitentiary. He was a "trusty," and for several days before his illness had been working on steamboats from Memphis, Tenn. Three fatal cases followed, with many cases of choleraic diarrhœa. The disease was again stamped out.

That the city of Little Rock in 1873 was not ravaged by cholera is due to the energetic action of Drs. Thompson, Dale, Lenow and Carroll in stamping out the disease in their respective cases, and the exertions of the health authorities in maintaining the city in good sanitary condition. An isolated group in a house epidemic is reported by Dr. Linthicum as occurring at Helena. In a family of seven individuals, six died in three days; the seventh made a lingering recovery. The excreta were carefully disinfected, and the hovel in which the cases had occurred (after the removal of the seventh case), with the contents, was burned.

The first recognized case of cholera at Memphis, Tenn., in 1873, was on April 15, in a man who had been in the city but a few days, having arrived by boat from the lower Mississippi. He died in a filthy boarding-house, near the river, after an illness of sixteen hours. The second case occurred April 30, in a man who kept an eating-stand on the levee, at the point where two railroad lines receive and discharge freight. This was also a fatal case, and it occurred in the adjoining block to the first case. May 1, a section boss on the Memphis and Paducah road, then in process of construction, was taken with cholera and died May 3, in his camp at section 26, on the line of the railroad. This man was constantly passing to and from the city, and his business carried him constantly to the point where the second case occurred. May 1, cholera occurred in a railroad camp at section 19 of the same road, but nearer to Memphis by seven miles than the camp at section 26. In a day or two cholera also appeared in camp on the same road at section 21. At sections 19 and 21 convict laborers were employed; at section 26, only citizens. The drinking water at all these camps was very bad, the surroundings of all were filthy.

On the death of "the boss" at section 26, a panic occurred; the laborers scattered in all directions, the majority going into the city of Memphis. The convicts, however, at camps 19 and 21 could not scatter; the disease spread rapidly among them, nearly all were sick, many died, but it was not until May 10 that any steps were taken for their relief. How often cholera had been brought into the city of Memphis before and succeeding the events from April 15 to May 10 which have been narrated, can never be learned. The city was in a shameful sanitary condition—there was virtually no health department. The mortuary statistics were kept by undertakers alone. Many non-fatal cases may have occurred, many defined cases may have arrived among the lower classes, and the city authorities have been none the wiser. It is probable that from the last week in April every steamer from the lower river brought to Memphis its quota of infection.

It is positively known that the steamer John Kilgore brought to Memphis the body of the man who died above Vicksburg; that at Memphis this body was placed in a casket, and that it was forwarded by rail from Memphis to Cincinnati, O., and that she also landed two cases of choleraic diarrhœa. It is positively known that no attempt at disinfection or isolation had been attempted on the Kilgore. After the stampede from the cholera camp at section 26, cholera rapidly spread over Memphis. The late Dr. J. H. Erskine, a distinguished sanitarian, who had great experience, describes it as the most violent he had ever witnessed. A very marked instance of the diffusion of cholera by an infected well occurred at Lucy station, a few miles out of the city.

On May 11, a gang of eighty convicts from the two cholera camps at sections 19 and 21, Memphis and Paducah railroad, arrived at the State penitentiary at Nashville, Tenn. At the time they left camp, the epidemic had not subsided. The deputy warden in command was so ill from cholera that he could not accompany them. A number of the comrades of these men had died of cholera. They were accompanied by four women convicts, who had served as cooks and washwomen. Every member of this party was sick with diarrhœa, having *copious watery stools accompanied in very many cases with nausea and vomiting,* when they reached the penitentiary. The four women were dangerously ill. On the day of the convict arrival there were 320 prisoners in the institution, of whom but twenty were on the sick report for ordinary disorders.

In 1873 all the penitentiary drains, from *privies, urinals, cesspools, kitchens* and wash-houses were emptied into what is known as the Lick branch, which flows through the western suburbs of the city and empties into the Cumberland river. The laundry and female department are in a separate inclosure on the southeast. The drainage from this portion of the penitentiary was for 100 feet in an open ditch along the east wall, when it entered an underground sewer and was by that conducted to the Lick branch. Upon the banks of the Lick branch, as it flows to the river, were many wells and two springs of much note by the inhabitants—one "the Judge's spring" the other appropriately named "the sulphur well." Two days after the arrival of the gang of convicts, one of their number died from cholera, and although the disease did not at once spread, yet during the remainder of the month a very marked increase in the prison sick report was observed.[1] May 20th, a negro woman living on the line of the drain from the female department was taken with cholera, but she did not die until the 31st. May 22, a man who lived opposite the point of exit of drain from the female department died of cholera. July 1, a negro, who had been discharged from the penitentiary three or four days previously, died of cholera in a shanty located in the eastern suburb and quite close to a noted spring, the water supply of the neighborhood, known as Wilson's spring. It was known that soon after the return of the cholera-infected convicts, several had been discharged and had returned to their former haunts in the city. By their influence the waters of Bilbo, Buck and Hackbury springs were undoubtedly polluted. July 8, a white convict in the penitentiary died of cholera, and the disease became epidemic within its walls. A frightful epidemic occurred in the city. Dr. W. K. Bowling collected statistics of 647 deaths, but it is probable that the true number of fatal cases far exceeded those figures, for in some of the suburbs, such as Rocktown and New Bethel, where the mortality was very great, many deaths were unreported, the burials being made by the people unaided by the authorities.

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[1] Narrative Cholera Epidemic of 1873 in the U. S., 1875, p. 149.

Cholera was carried from Nashville to Goodletsville, Gallatin, Shelbyville, Murfreesborough, Lebanon, Clarksville, Palmyra, Farmington, Chattanooga, Greenville and Union City. At each point the trail of epidemic infection was very clear. Each point named was free from the disease until after the arrival of one or more cholera-infected individuals from Nashville. Each point to which cholera was carried in turn transmitted the disease to other localities, Knoxville receiving the infection from Chattanooga.

The epidemic of 1873 in the State of Kentucky opened with the arrival of the steamer John Kilgore at Paducah, May 18. The officers of the Kilgore denied that cholera had been on the boat, and during the stay at Paducah several persons of the town spent some hours on her decks and in her cabins. May 21, a young man who had been on the Kilgore was taken with cholera and died in eight hours. May 23, the man who nursed him also died, and three other cases of those who had contact with the Kilgore followed, when that group of infection closed. June 3, a woman arrived at her home in Paducah from a visit to Memphis, Tenn. The night of her arrival she was taken with cholera and died early the next day. July 5, a woman who had nursed her took the disease and died in 48 hours. From these cases the epidemic spread, intensified by fresh cholera arrivals June 10, on steamer Quickstep; June 19, on steamer Fish, and later by every steamboat that made the landing. The history of this local epidemic is full of instructive instances of cholera diffusions.

At Bowling Green, Ky., cholera was imported from Gallatin, Tenn., June 3, and by the clothing of a man who had died on a steamboat after leaving Evansville, Ind., June 13. The clothing was washed at Bowling Green after the arrival of the boat by a negro woman, who died of cholera within thirty-six hours from the commencement of her task, and her death was followed by 86 cholera cases, with 65 deaths. At Louisville, from June 8 to August 16, twenty-one fatal cases occurred. All were in persons who had contracted the disease in some cholera center. That no epidemic occurred is alone due to the sanitary measures which were adopted in every case. Louisville escaped an epidemic of cholera from exactly the same reason that afforded immunity to Little Rock, Ark. That was the vigilance of the health authorities and medical practitioners. In but one instance was there any sequence of cases. A family consisting of a mother, two single daughters, two married daughters, the husband of one daughter and two grandchildren, lived in a small house in the western side of the city. Aug. 22, Mrs. G., who had been confined two weeks previously, went to Bowling Green to visit her husband. Aug. 25, she was taken with cholera and died. Aug. 28, her body, in a wooden coffin, was taken to her mother's house in Louisville and the coffin opened. Sept. 2, a child was taken with cholera, but recovered. Sept. 4, one single daughter died of cholera; the same day the infant of first case died. Sept. 6, the married sister was taken and died Sept. 7; the remaining daughter took the disease but recovered.

Cholera was almost universally diffused over the State of Kentucky; very few counties escaped the disease. A careful study which was made during and immediately after the epidemic showed most conclusively that the disease was carried over the State by the migrations of cholera-infected individuals. I shall select the epidemic as it occurred in but three localities for the present study. The outbreak of the disease in Taylor county is of value, for in it is found the first link in a most virulent demonstration of the disease. A negro man, who had been working in a construction party on the Memphis and Paducah R. R., obtained employment on the Ohio and Cumberland R. R., and was placed in a gang working on the tunnel section at Muldrough's Hill. July 10, he was taken with cholera and died in one of a group of negro cabins built upon a hillside, and immediately above a spring from which all the neighborhood obtained water. The dejecta were thrown out on the ground around this cabin. On July 14, 15, and 16 there were heavy rainfalls, and everything on the hillside washed down into the spring, nearly filling it with debris. July 17, a severe and virulent epidemic followed among the residents of the cluster of cabins.

July 19, a negro from this locality (one of the railroad gang) died of cholera in the town of Lebanon. The death occurred in a shanty on the north side of the town and on the banks of a small stream called Jordan, which flowing through low ground to the west, forms one main drain of the town. The cases was not reported and no disinfection was employed. Aug. 11, a negro woman, also from the Taylor county focus died of cholera in a cabin on the banks of Jordan. From August 11 to August 18, several such cases occurred among negroes living in the same locality, all of whom died. Aug. 18, a white man, who also lived in the same locality, was taken ill, but recovered. Aug. 19, a young woman living in the same line took the disease but recovered.

None of these cases had been recognized as cholera, in none were disinfectants employed. The excreta of all were emptied into or on the sides of the Jordan, then almost dry and choked with debris. August 19, a white man who lived upon high ground at some distance from "Jordan," was taken with cholera and died after a five-hours' illness. It was found that he had been a constant visitor of a woman who lived in the infected locality. In this case the excreta were disinfected and buried. Aug. 25, a third case from the infected camp in Taylor county died. Again every precaution was neglected. It was impossible to awaken any public interest in these cases. The physician in whose hands the majority occurred denied that they were cholera, and all warnings of future danger were ridiculed.

August 26 the Marion county fair, was opened on the grounds near Lebanon. All water used on these grounds was carried by carts from the town. A public well on the western side of the town, near the railroad station, and on the banks of Jordan, was selected to furnish the necessary supply. At that time Jordan was no longer a stream, and the water in the well was limited. August 27, a violent rain-storm occurred, Jordan was filled to overflowing, all the debris and cholera stuff which had been accumulating since July 19 was washed down its course and over its banks. The town well was full to overflowing. During August 28 and 29, the attendance upon the fair was very large. No cases of violent illness had occurred in the town since August 25, and a fatal security seemed to possess all. At midnight Aug. 29 the blow fell, and before daylight of Aug. 30, thirteen cases of cholera had occurred, of whom twelve died within the next ten hours. Each individual in the series of cases had been in attendance upon the fair. All had drank the water furnished. Age, sex or social condition had no bearing upon the cases. At almost the same hour at which this Lebanon epidemic developed, cholera occurred in the country for miles around; wherever individuals lived who had visited the fair grounds and had drank of the water, cholera occurred, no matter how isolated the location or how free it had been from disease. The epidemic lasted to Sept. 14, but isolated cases continued to occur until October. From the Marion county fair grounds cholera was carried into Nelson county, where several malignant house epidemics occurred; to Columbia, Adair county, where a malignant house epidemic (Winfrey House) occurred in the first instance, which spreading, almost depopulated the town; to Washington and Boyle counties where local epidemics followed.

The history of the epidemic in Gerrard county is very instructive. Aug. 10, 1873, a man named Bewley arrived at Lancaster sick with a profuse diarrhœa, from which he had been suffering for several days. He had left Russellville, Tenn., after cholera had become epidemic at that town. He had made the journey on horseback. On his arrival he was lodged by a friend who lived on the eastern side of town, upon a hillside, at the foot of which was a public well from which many people obtained water. The day after his arrival cholera developed, but he did not die until Aug. 22. The excreta in this case were thrown out upon the ground in the rear of dirty outhouses. Aug. 14 a negro man who nursed Bewley was taken with cholera and died, after an illness of eight hours, in his cabin, near the before-mentioned well. Aug. 15, the father-in-law of Bewley who had come from his home, ten miles from town, and who had slept the previous night in the room with Bewley, died after a few hours' illness. Aug. 16, a negro woman who lived in a cabin near the house in which Bewley's nurse died, and who drank the water from this well, was taken with cholera, and died after twenty-two hours' illness. Up to this time no disinfectant had been used; the excreta from each case werescattered broadcast upon the ground around the dwellings. Each succeeding day fresh cases occurred, at first confined to those who drank the water of the well mentioned, but the disease soon spread over the town. The epidemic lasted from Aug. 14 to Sept. 5. The house in which Bewley died had been closed, but when the disease disappeared the family returned. On Sept. 20, an old lady came to Lancaster on a visit. She put up at the house in which Bewley died and occupied his room. She slept on the bed one night, when she was taken with cholera and died. At Stanford, Ky., a malignant epidemic was occasioned by refugee negroes from Lancaster.

A very interesting instance in support of the theory that an epidemic of cholera may occur whenever the specific poison of the disease finds a suitable hotbed for its propagation, was Clinton county. While cholera was epidemic at the town of Columbia, the judge and commonwealth attorney of the sixth judicial district of Kentucky left Columbia for Albany, Clinton county. They had been in Columbia for the previous two weeks, had lived in the Winfrey House, and the night before they started on this journey had nursed a friend sick with cholera, taking turns in watching. A few miles from Columbia, Mr. Adair, the commonwealth attorney, complained of malaise and nausea. These symptoms became more severe until 5 o'clock that evening, when vomiting and diarrhœa came on; he was obliged to dismount and lie upon the ground. He was soon after carried to the house of a man named Kelly, which was not far distant, where he was placed in bed and a violent attack of cholera developed. This was on August 31. The attack was typical, and although Mr. Adair ultimately recovered, his convalescence did not begin until Sept. 10. Mr. Kelly's house was located high up on one of the spurs of the Cumberland mountains; so isolated that the owner did not know that there was such a disease as cholera until the arrival of Mr. Adair. The excreta of this case were not disinfected, but were thrown into the privy and upon the ground about the house. Mr. Kelly, his daughter, and a negro servant died of cholera; a young man also took the disease, but recovered. These cases all occurred while Mr. Adair was in the house sick, and the last death occurred before he was pronounced convalescent. From Columbia, cholera was carried to Jamestown, Russell county, where two severe and fatal house epidemics occurred.

The cholera invasion of the State of Illinois dates from May 24, when a man who had been employed as a bridge builder on the Memphis and Paducah railroad, died of cholera, in Chicago. No other cases occurred in that city until June 10, when a cholera death occurred in a house occupied by several Danish families, and in which an emigrant lately arrived from New Orleans had been sick with what was supposed to be typhoid fever. From this case a local epidemic occurred, consisting of eight cases, all having an epidemic connection, and from them a circumscribed epidemic occurred fed by occasional importation. That no serious epidemic occurred in the city of Chicago was due to the activity and vigilance of the health authorities.

A few cases occurred at Cairo, Ill., June 15, in a negro from New Orleans, June 20, in a man from Memphis, who was found drunk on the streets and lodged in the jail, when cholera developed; he was discharged from the jail and died in hospital. June 23, the wife of the jailer, whose room was immediately above the cell occupied by this man, was taken with cholera and died. Three other local cases were reported. Disinfectants were freely used.

At Grand Tower, Ill., twenty-four cholera cases were reported, with fifteen deaths. The connection of the first cases could not be positively determined, but the epidemic influence once established, the spread of the disease was easily traced; and the same statement is true in regard to cases which occurred in Marion, St. Clair, Jersey, Scott, and a few other counties. At White Hall, Greene county, the epidemic followed the arrival of a cholera corpse from St. Louis. At Carmi, White county, the first case occurred after the subject had returned from attending the funeral of a cholera death at Evansville, Ind. At Okawville, Washington county, the initial case contracted the disease at St. Louis, Mo. At Rock Island, the disease was imported from Davenport, Iowa. At Villa Ridge, one case was taken from a Mississippi river steamer; the only other was his father-in-law. In the majority of these instances the disease was confined almost exclusively to house epidemics; in Washington county alone did the epidemic spread through the community.

It was a matter of great difficulty to obtain reliable facts as to the epidemic of 1873 in the city of St. Louis, Mo. Mr. John Moore, the most recent investigator, dismissed that epidemic in a few words: "In 1873, when cholera appeared again, it was hardly recognized as such, and the victims as counted by Doctor M'Clellan from reports of local physicians numbered 392." The absolute truth is that an epidemic of cholera did occur in the southern sections of that city, in a densely crowded population, living in tenement houses and dirty alleys, where all the disadvantages of deficient ventilation, defective drainage, and bad water from surface wells contributed to the epidemic diffusion. The first case in the city (which was recognized) was on May 11th in a man who had, just before his attack, returned from New Orleans. This case was fatal, and within a week of his death seven other persons who lived in the house died of cholera. From this center the disease spread, and from it cholera was carried into a similar neighborhood in the northern limits of the city where a second focus was established. The health officers (at that time) reported that 392 cases of cholera deaths had occurred with 137 deaths from cholera morbus; but it is most probable that at least 529 deaths occurred from epidemic cholera. During the course of this epidemic many interesting cases were reported, and the efficacy of the prompt and efficient use of disinfectants was fully demonstrated. The history also shows that the Mississippi river steamers were again cholera-infected; that by them the disease was brought to the city of St. Louis and also to other river towns of Missouri. From St. Louis cholera was carried to Jefferson City, the State capital. The State penitentiary was infected by a gang of prisoners employed in unloading a Missouri river steamboat.

The epidemic in the State of Indiana opened at Mount Vernon, an Ohio river town. The steamboat John Kilgore from New Orleans, landed a short distance above the town on May 20. A man residing near the landing who had been on the Kilgore during her stay was taken with cholera at his house, died, and ten cases of cholera with eight deaths can be traced to him. A citizen of Mount Vernon died of cholera at Nashville, Tenn.; his brother went to Nashville and returned to Mount Vernon with the body. The coffin was opened for inspection. Eight cholera cases followed in that family. From May 26 to June 21, six steamboats from either New Orleans, Memphis or Nashville landed at Mount Vernon, all having cholera on board. In addition, the Ohio river steamers (all cholera infected) made daily visits going up and down the river. June 21, the steamboat Camelia landed a gang of negroes from Nashville; one of these negroes died of cholera on the wharf-boat soon after he was landed. Other cases occurred rapidly and a violently persistent epidemic followed. No systematic disinfection was attempted.

The city of Evansville received the initial importation of cholera from the steamer John Kilgore on her trip up the Ohio river, in the person of a deck hand, whom she left in the stage of collapse. Other cases were subsequently left by other steamers. Strict sanitary measures being adopted, but a slight epidemic followed. The importation of cholera into Indianapolis could not be traced, but the first cases occurred opposite to the Union passenger railroad station. The disease was confined to but two houses. A German woman, who had been in one of the Indianapolis infected houses, died of cholera at her home at Cumberland, ten miles east of Indianapolis. Her funeral was largely attended. Five days later fifteen cases of cholera, eight of which were fatal, occurred among those who had attended the funeral, and an epidemic followed of over eighty cases. At Lawrence, Ind., a young child from one of the Indianapolis infected houses, died of cholera. The funeral was largely attended and an epidemic followed, which was prolonged by the attendance upon subsequent funerals of cholera-patients, forty-four cholera cases with twenty-four deaths occurred. These last two instances occurred in farming communities where friends came from distances to attend funerals, eating and drinking at the house of mourning. At North Vernon and Terre Haute a few isolated cases occurred. At Aurora, a man from Cincinnati died of cholera, July 27. His dejecta was thrown out on the ground near a public well. The water from this well was used by many families, and fifteen well-marked cholera cases occurred among those who lived within a radius of four hundred yards of this well.

The absolute truth of the importation of cholera in 1873 into the State of Ohio, stripped of all the fallacious arguments at the time employed to conceal it, is that the disease was imported from New Orleans, La., by the steamer John Kilgore, on May 22; the steamer Charles Bodman, May 24; the steamer H. S. Turner, June 6; the steamer C. B. Church, June 14; and the steamer Nicholas Longworth, June 23; that it was imported from Memphis, Tenn., by the steamers Pat Rodgers, Arlington, Mary Houston and James D. Parker; that a third source of epidemic infection were the steamboats Eddyville and Camelia from Nashville, Tenn. Each of the boats named had cases of cholera and choleraic diarrhœa on board. On the Parker every one on board had symptoms of cholera save the captain and clerk. Later in the season all the steamboats on the Ohio river became cholera-infected and, by all, persons and merchandize which had been exposed to the specific infection were landed in the city of Cincinnati.

Cincinnati being the home station of most of the steamers on the Ohio and lower Mississippi routes, the bed linen used upon them is usually washed by laundresses on shore. On the Nashville and St. Louis boats, such washing is generally done on board by laundresses from the shore, but at times the linen is taken on shore. Dr. Clendenin, through whose exertions, the light of truth shines on this local epidemic, states: "These facts are certainly possessed of the most important bearing upon the history of the introduction of the disease, and from them the diffusion of cholera over the city of Cincinnati may be accounted for."

The first cholera death in the city of Cincinnati occurred at the city hospital on the 27th of May, in a man who arrived by steamboat from some Kentucky point May 22. "The day before he was admitted he was taken with diarrhœa, cramps in his legs and vomiting." This case lingered until May 27, when he died. At the Cincinnati hospital the excreta of all patients was placed in drains which emptied into the public sewers; disinfectants were freely used and the drains were constantly flushed with water. In the laundry, superheated steam being employed, the most efficient disinfection of fabrics was secured. May 26, a child died of cholera, at the home of its parents, which was at the point of the river bank, east of the city, where steamboats are tied up when not making regular trips. June 6, a third cholera death occurred at a large hotel (the Burnet House), in the person of a young child of a family who had arrived the day before from *the South*. During the season 207 cholera deaths were reported by the health office, no record was taken of non-fatal cases, and diarrhœal cases were too trivial to attract notice. The disease was diffused through the districts of the city inhabited by the poorer classes. It was an epidemic during which innumerable foci of infection were established, but which were promptly stamped out. But for that fact the disease would have been as malignant in Cincinnati as it was in some of the small towns on the Ohio river. It is well at this point to record the data in relation to the steamer John Kilgore. This steamer left New Orleans, La., May 13 (during the month of May 125 cholera deaths were reported in New Orleans.) She had a large list of passengers, many of whom were on deck, and most of whom were flatboatmen, from different places on the Mississippi and Ohio rivers. The day after leaving New Orleans, a Mr. Schenck of Cincinnati, a cabin passenger, was taken with cholera; when the Kilgore reached Vicksburg, Mr. Schenck was still alive and the services of Dr. Booth were obtained. Mr. S. died at a point about 50 miles above Vicksburg, and his body was carried to Memphis. The excreta of this case was not disinfected, nor was any care taken with the clothing, bed or bedding. On reaching Memphis, a casket was obtained for the body, which was then forwarded by rail to Cincinnati. Two passengers went ashore at Memphis with choleraic diarrhœa. At Paducah, Ky., an epidemic occurred from contact with this boat. After leaving Paducah, three deck passengers died from cholera; one was buried near Shawneetown, one near Rome, and one above Evansville, all on the Ohio. Her arrival was the first cause of the violent epidemic at Mount Vernon; and had not the health authorities of Louisville been active and vigilant she would have infected that city, for there she landed the greater portion of her deck passengers.

At Carthage, ten miles north of Cincinnati, a most interesting illustration of the portability of cholera occurred. A man named Tenthave, his wife, five children, a sister of the wife, and two young men, arrived in New York on the steamship City of Limerick from Liverpool on July 5, 1873. They left New York City July 6th for Carthage, Ohio, via the Baltimore and Ohio Railroad. On July 10th they arrived at Cincinnati, too late to proceed that day on their journey, and the entire party spent the night in a station-house. Early the next day they left Cincinnati for Carthage. July 13th the boxes and bales of household property arriving, the entire party took possession of a small house. Everything was unpacked for use; the bedding and clothing had not been touched before since they were packed up at Tubbergen, Holland. July 15th a child was taken ill with cholera; a few hours later the father and a second child took the disease. July 16th the mother sickened; July 17th a third child had the disease; July 19th, a fourth child; July 22d, the fifth child; July 23d, the young woman was attacked. These cases all terminated fatally in from eight to twenty-four hours. The two young men suffered severely from diarrhœa, but recovered. Living in the rear of this infected house, some one hundred yards distant, was a young married woman, pregnant with her first child. Forbidden by her husband to go near the Tenthave house, she each day provided some articles of food which she placed on the fence in the rear of the cholera house. Each day she received the utensils in which this food had been served. July 23d she was taken with cholera and died after forty-eight hours' illness, aborting twenty hours before death. By Doctor Bunker, who had charge of these cases, disinfectants were employed, and the disease did not spread in the town of Carthage. On the 21st of July, however, cholera suddenly developed in the negro wards of Longview insane asylum. This institution is located on the southern side of Carthage. The negro wards are in a detached building at some distance from the main institution. It was supposed that a perfect system of non-intercourse had been preserved, but the investigations of Dr. Clendenin proved clearly that such was not the case. Joseph Marshall, a negro, the supervisor of the attendants in the negro wards, impelled by curiosity, went frequently to the infected house. After the last death in the Tenthave family, the man Marshall appropriated to his own use a braided shooting-coat which had belonged to Tenthave. He carried the coat to the asylum, and, as he found it wet, hung it up on the back porch to dry. While in this position it attracted the attention of a patient, who took it down, wore it for the remainder of the day and slept in it that night, when it was again taken possession of by Marshall. The next day the patient who had worn the coat and four other patients were taken with cholera; when Marshall, properly connecting the outbreak with the stolen coat, burned it at the kitchen fire. From this importation thirteen cases of cholera, with nine deaths, occurred.

At Dayton, Ohio, the epidemic was confined to but two houses. At several other points isolated cases occurred, but which, with two exceptions, are traced back to the house epidemic. The only direct importation which could be traced was a man from Memphis, Tenn., who died in a hotel. His case, however, was disconnected with those that followed. Dayton, however, is a great railroad center, and to the efficiency of railroads as common carriers of infection as well as merchandize must be ascribed the occurrence of the disease at Dayton, Springfield and Columbus, Ohio. At the last-named city the initial case occurred in the person of a woman who kept a low grog-shop under the bridge of the Pittsburgh, Cincinnati and St. Louis Railroad as it leaves the city. The position is such that a cholera dejection or a choleraic diarrhœa discharged at that point would inevitably fall at the back door of that house.[1] Not only did the initial case occur at that point, but the majority of the early cases were in its immediate vicinity. After the epidemic had gained full headway in the city, that was the most virulently infected district. Cholera was carried within the State penitentiary walls by guards, teamsters and night watchmen who lived in the infected locality. Of twenty-seven cases which occurred in the penitentiary, twenty-one were fatal.

It was impossible to trace any direct connection between the early cases at Wheeling, West Virginia, and any well-defined focus of cholera infection. They, however, occurred in localities which from their filthy condition were most favorable for the reproduction of the disease. The epidemic having obtained a foothold, many instances of the diffusion of the disease were found. The earliest cases were on June 9th and 20th. Doctor S. L. Jepson states that the steamers Andes and R. R. Hudson, the weekly packets between Cincinnati and Wheeling during the months of June and July, brought many sick with profuse diarrhœa from the former to the latter city.

At Pittsburgh, Penn., on July 29th, a man and his wife returned to their home after a visit to Cadiz Junction, Ohio. August 1st the wife was taken with cholera and died August 4th. The day of his wife's death the man was seized and died. Aug. 6th a woman who had nursed these cases was taken with cholera and died. The most active sanitary precautions were adopted. Clothing, bedding and carpets were burned. Aug. 8th, a man who had been employed to destroy this property was taken with cholera and died Aug. 10th. No spread of the disease occurred. The husband of the first case informed his physician that while he was at Cadiz Junction cholera was epidemic among railroad employees.

Three well-defined points of cholera infection occurred in the State of Alabama. In anticipation of cholera infection, the city of Huntsville was placed in as good sanitary condition as was possible. No connection with the epidemic as it existed at either Memphis or Nashville, Tenn., could be found, except that the early cases occurred on low ground, along the line of the railroad and about 100 yards from the station. The epidemic, however, once started, the disease was carried wherever individuals who had been exposed to the infection resided. It was carried to Monte Sano, a mountain watering-place, and to Johnson's Wells. At Birmingham, June 12th, a man who had been in the city for six weeks, and who was in perfect health, was taken with cholera and died after a day's illness. Three days before this attack he had received his bedding from Huntsville, and had used it up to the time of his death. June 17th a case of cholera occurred in a family who had constantly been with the first case, and before the close of that day there was another case in the same family; both died. No disinfectants were used in either of these three cases. The discharges of all were thrown into a small almost dry "branch" which ran through low marshy ground, from which many people obtained their drinking water. June 19th a man who had just returned from Chattanooga, where he had been for several weeks, died of cholera after eighteen hours' illness. From these cases the epidemic spread in most virulent form.

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[1] While in railroad stations it is customary to keep the closets in cars locked and not to open them until the station is left.

From Birmingham cholera was carried to the city of Montgomery by a negro man who had been employed as a cholera nurse; no epidemic followed. The city was blessed with a most efficient health officer.

In but two instances could cases of cholera be discovered in the State of Georgia. Both were in the persons of refugees from the disease at Chattanooga. One case was at Atlanta, the other at Dalton; both terminated fatally both were carefully isolated and disinfected. No other cases followed.

At Crow river, Kandiyohi Co., Minn., occurred an interesting group of cases in the family of Swedes named Antonson. This family arrived at New York on the steamer Peter Japson, June 26, 1873. From New York city this family were transported to St. Paul, Minn., via Pittsburgh, Penn., Grand Haven and Milwaukee. They rested twenty-four hours at St. Paul, when they started for Crow River, via Willmar, Minn. They arrived at Crow River July 2d. Before leaving Bergen, Sweden, the effects of this family were packed, except hand baggage. When they arrived at Willmar, Minn., their property was unpacked for additional articles of clothing, and the next day Antonson sickened with cholera, but he did not die until July 10th. July 6th a son was attacked and died in forty-eight hours; July 9th a daughter was taken and died in twenty hours; July 12th another daughter died after ten hours' illness, and the same day the man at whose house in Crow River they had stopped died of cholera eight hours after he was attacked. Two other non-fatal cases occurred. The recital of this group of cases greatly disturbed Pettenkofer, who endeavored by ridicule to bring discredit upon it. But in spite of all subsoil water theories, the case stands, and after a lapse of ten years I have no hesitation in bringing it forward again.

At Davenport, Iowa, an epidemic of eighty-nine cases of cholera, with forty-three deaths, followed the arrival of cholera cases on a steamboat from St. Louis, Mo., on August 14th.

At Kelton, Utah, a house epidemic occurred Aug. 18th in a family recently arrived from Missouri.

At Yankton, Dakota, a virulent epidemic of cholera occurred among Russian emigrants, and at a Russian colony a few miles distant; a few cases of cholera occurred in the city of Yankton, but no diffusion of the disease occurred. Among the Russians the epidemic closely followed the arrival of a large party who had recently arrived from the Odessa district.

During 1873 cholera was repeatedly brought into New York harbor, but in no instance did it escape the quarantine grounds.

CHAPTER IX.

CHOLERA IN BOMBAY, ESPECIALLY IN 1883.

ALMOST all the interest in cholera from India now centers upon Bombay. Thus Bombay is connected with Calcutta, Madras and Allahabad by railroad, and can get cholera from them; but it also has pestilences of its own every year. Cholera has prevailed in Bombay city and its Presidency every year since 1848, and almost every month in the year. The most dangerous months are March, April, May and June, perhaps also July; then the cases fall off rapidly in August, September, October and November, to increase twofold in December, January, February and March. In June the great southwest monsoons or rain storms come on and flood out the disease.

It is encouraging that cholera is generally far less prevalent in Bombay than in olden times; since the great epidemic of 1865 the deaths have scarcely ever reached an average of 1,000 per year for the whole city, only in 1877, when they counted up 2,510; in 1878, 1,165; in 1883, 1,014.

In 1883 the epidemic commenced in May with 84 deaths; in June there were 84; July, 231; August, 429; September, 152; and then they fell off rapidly with only 24 deaths in October, 4 in November, 37 in December, only 2 in January, 1 each in February and March, and 15 in April.

The cholera of 1883 in Egypt, probably derived from Bombay, commenced in May and died out in midsummer, aided by the great drought, which is just as destructive to cholera germs as excessive rains. The great rise of the Nile also flooded out the pestilence. The cholera of Toulon, Marseilles, France, Italy, Genoa and Naples, Spain and Algiers, died out unusually early in the fall.

The great cholera months in Calcutta are February, March, April and May; out of 25,000 deaths, there may be 12,000 to 16,000 deaths in May, but there will be only half that number in June, and only one-third in July, August and September. But they will double up in October, November, December and January. The February, March, April and May Calcutta germ may be more hardy and last over winter in Europe and America.

The Bombay Presidency covers 124,000 square miles; the population is 16,000,000. The year 1883 was an unhealthy one, as there was not only a wide-spread epidemic of cholera, but much small-pox, while fevers were in excess and locusts abounded. There was unusually heavy rain with the southwest monsoon in June, while the easterly rains in September and October were more abundant and prolonged than usual. There were 500,000 births and 420,000 deaths. Among the 3,000,000 Mohammedans there were 57,000 deaths; of the 13,000,000 Hindoos there were 355,000 deaths; of 140,000 Christians, 2,700 deaths; of the 80,000 other castes, outcasts and pariahs, 4,000 deaths.

CHOLERA MORTALITY BY MONTHS FOR THIRTY-FIVE YEARS IN BOMBAY CITY.

YEAR.	JANUARY.	FEBRUARY.	MARCH.	APRIL.	MAY.	JUNE.	JULY.	AUGUST.	SEPTEMBER.	OCTOBER.	NOVEMBER.	DECEMBER.	YEAR.	TOTAL.
1848	..	17	7	17	10	9	6	2	2	..	5	..	1848	60
1849	..	..	1	4	1	..	..	121	690	369	260	682	1849	2128
1850	141	53	269	607	296	259	324	348	143	51	53	453	1850	2997
1851	1873	905	1013	601	373	339	73	37	25	19	20	207	1851	5485
1852	408	91	160	271	149	151	105	66	19	10	6	24	1852	1520
1853	23	8	8	5	16	9	6	6	6	250	571	240	1853	1148
1854	214	209	372	724	520	950	317	68	14	11	9	9	1854	3507
1855	60	22	22	302	585	273	167	52	75	46	21	20	1855	1645
1856	154	266	241	358	280	197	89	22	19	38	40	142	1856	1846
1857	459	165	306	363	249	302	157	86	32	31	18	13	1857	2181
1858	19	9	8	15	11	9	5	8	11	6	7	7	1858	115
1859	9	10	9	7	69	843	329	170	41	85	131	282	1859	1985
1860	289	332	396	321	163	107	89	128	51	47	29	9	1860	1961
1861	15	18	5	4	12	18	13	10	11	34	35	406	1861	641
1862	625	240	339	266	367	218	117	95	161	272	201	209	1862	3170
1863	89	50	89	161	153	161	412	240	178	181	176	319	1863	2209
1864	622	401	302	680	837	395	371	351	232	88	137	431	1864	4847
1865	363	540	522	356	624	206	116	62	31	32	22	13	1865	2887
1866	13	15	12	16	21	15	27	43	63	49	31	27	1866	332
1867	11	21	12	26	5	9	5	5	7	6	4	..	1867	111
1868	157	..	..	3	3	2	4	6	1	43	63	101	1868	227
1869	6	93	97	91	82	41	54	47	60	26	3	3	1869	754
1870	68	3	5	3	7	12	4	73	76	41	64	92	1870	386
1871	7	41	37	24	15	10	3	11	13	29	8	4	1871	263
1872	..	2	4	7	6	7	46	54	32	11	3	11	1872	196
1873	22	13	17	12	8	7	3	1	2	3	2	2	1873	92
1874	1	..	2	2	7	..	2	1	2	2	..	..	1874	19
1875	1	1	..	31	7	132	279	168	43	53	58	21	1875	824
1876	1	..	2	4	5	9	119	141	64	22	6	..	1876	374
1877	1	61	111	185	337	704	495	357	162	42	21	54	1877	2510
1878	35	109	224	128	137	99	156	116	43	53	40	25	1878	1165
1879	27	10	13	4	29	14	33	74	64	41	10	4	1879	323
1880	8	6	3	2	2	2	1	1	1	2	1	1	1880	30
1881	..	..	3	9	68	85	111	73	48	33	9	91	1881	529
1882	80	52	12	5	1	..	12	12	8	2	..	1	1882	190
[illegible]	106	110	132	161	158	160	117	87	69	58	59	115		1391
1883	2	1	1	15	84	34	231	429	152	24	4	37	1883	1014

"In 1883, in January, the pestilence had nearly died out, as only 28 deaths were recorded throughout the whole Presidency. In February, it had almost entirely disappeared, as only ONE doubtful case was reported. In March, too, only 19 deaths occurred; but in April, the disease suddenly assumed an epidemic form, as 906 deaths were recorded. In May a still further and very great increase took place, as 5,622 deaths were reported. In June, 9,447 deaths occurred, and in July the mortality rose to the very serious amount of 12,708—the maximum for the year. In August the pestilence began to abate rapidly, as ONLY 6,733 deaths were reported, and in September the death rate fell to 1,230, and in October to merely 665. A further decrease was observed in November, as only 340 deaths were counted, and in December the pestilence had declined to 146 for that month.

"In the Presidency, out of 37,954 cholera deaths in 1883, 19,587 occurred among males, and 18,097 among females.

'In Bombay city with a population of 773,196, in 1883 there were 1,400 attacks, 612 in males, 402 in females; the rest were children. The percentage of deaths to attacks was 69 per cent.

"In the military cantonments, with a population of 51,573 persons, there were 45 deaths; so that they would not convey much disease to Europe on the fine P. & O. steamships.

"Out of the 24,536 villages in the Presidency, 3,199 were attacked, or 13 per cent. In Kandeish out of 2,679 villages, 764, or 28 per cent., were attacked. In Ahmednuggur, just east of Bombay, out of 1,331 villages, 623, or 46 per cent., were involved. In Poonah, just below Bombay, 471 villages out of 1,181, or 40 per cent. In Nassick, just north of Bombay, 342 villages out of 1,629, or 21 per cent. In Holopur, southeast of Bombay, 207 villages out of 709, or 38 per cent."

The outbreak commenced March 15, 1883, at Nassick, northwest of Bombay, where there are great and beautiful temples; next at Ahmednuggur to the east, April 9th. At Bombay city it was rather later.

CHAPTER X.

CHOLERA IN EGYPT IN 1883.

In June, 1883, cholera was suddenly announced at Damietta on one of the mouths of the Nile nearest Port Said, the outlet of the Suez canal. Damietta has about 35,000 inhabitants, and in addition 15,000 more people came to a great yearly fair. A mixed commission of eleven English, French, Italian and Egyptian physicians was sent from Alexandria, and on June 25th reported the disease to be cholera; and from the rapid spread of the pestilence, the number of nearly sudden deaths, the great number of persons attacked, the large portion of fatal cases, the area over which the disease had already spread beyond the city, they declared it to be epidemic cholera. At this late date they were unable to decide whether it arose locally or was imported. They decided that the great outbreak commenced on June 19th with six deaths, which is impossible, for there must have been previous cases. The health officer had only noticed the disease on June 22d and 23d, when there were 14 and 23 deaths, which he thought rather much for a beginning. The town is traversed by a canal, which receives the contents of the drains of the mosques and houses on its banks, yet is used for drinking water by part of the people; hence there seemed to be no infection from one case to another, but only numerous cases from the drinking water; and partly from the unwholesome gases and effluvia from the latrines and drains, especially those of the mosques which were so largely visited by the fair people. The flesh of animals dead of bovine typhus was said to have been sold in large quantities. A great many dead cattle floated down the river and lodged near the town; many stale salt fish were also used for food. Hence the localists made out a good case at first.

July 14th, or more than a month after the outbreak, Surgeon-General Hunter was sent from England to examine into the origin of this epidemic as its nature as Asiatic cholera was already admitted.

The British consul also adopted the local theory, and put the origin of the disease on the bad sanitary condition of the town, the bad meat used, the impure water, and the overcrowding of people at the festival. He says it could not have been imported, as the nearest place where it prevailed was Bombay, and there he was erroneously assured it was not epidemic. But there had been 84 deaths in Bombay city in June, and before the year ended there were 37,954 in the whole province. He was on the Egyptian Sanitary Council, and takes pride in saying that he had fought many a battle with his colleagues in the interest of British shipowners and the vast English commerce in the East.

All the 15,000 fair and festival people were driven out of Damietta and 10,000 of the inhabitants allowed to go with them; and then a cordon of 400 soldiers was put around the town and no one allowed to go in or out; even provisions and medicines were stopped so that the rest were almost starved. But the pestilence was already scattered broadcast over Egypt. The outbreak was so sudden that contaminated water could only have been the cause. On June 20th there were only 4 deaths; June 21st only 1; June 22d, 14; 23d, 23; 24th, 42, and 15 more were suspected to be cholera; 25th, 42, and 32 suspects; 26th, 47, with 37 suspects; 27th, 129; 28th, 106. All was in doubt and suspicion till the 27th.

The markets, slaughter-houses and public privies were supervised; fresh fish, vegetables and fruit were seized; stale fish, hides, bones and rags were all placed in special warehouses. The latrines of the mosques, prisons, barracks, schools and all public places were disinfected, and the houses of the sick also. Rags and soiled clothes were burned; cholera hospitals were established in other cities, in advance. The house and street drains emptying into the canal were closed and quicklime thrown into them and it. The people were driven out of their houses into tents and sheds. Inside the cordon, the houses were cleansed and the worst hovels demolished. These measures had apparently arrested the epidemic of 1865, which was the last Egypt had had; *i.e.* there had been no cholera for twenty years in Egypt, notwithstanding all its filth and fairs.

The sanitary doctor of Port Said came and said the symptoms were very marked and decisive, and were undoubtedly those of Asiatic cholera, and that the disease must have been imported. As late as July 7th, Dr. Mackie said no real attempt had been made to arrive at its origin or cause. It was established that the bovine typhus prevailed first; that many dead animals were thrown into the Nile, and the people were drinking this foul water. There was a sudden access of hot weather, which was excessive; the dampness and the uncleanliness of Damietta, like that of every Egyptian town, were abominable, yet only Damietta was attacked at first, and the other towns only after refugees had come to them. Port Said and Tantah, which had another horrible fair and festival, were the second places attacked.

Alexandria escaped for a comparatively long time, although it had a vile system of sewers, and house drains, with open latrines for servants in the very center of the kitchens. The sewers had never been cleaned and could not be cleaned, and they were neither trapped nor ventilated, nor yet the house connections upon them.

Four Bombay merchants and a fireman of the Bombay steamship Timor were now charged with bringing cholera to Damietta, but could not be found. All the cases in Alexandria (78) up to June 30th had been at the Damietta fair, or came from two steamships, the Kate and St. Bernard, which came from Bombay on June 30th with cases on board.

A large number of refugees went to Mansourah, without money or food, but as the wind was northwest, cholera was supposed to have been blown by it from Damietta; but the northeast part of the town was first attacked; fruit and vegetables were entirely prohibited, and the place was cleansed as well as possible, while fires were lighted in all the streets. The nationality, age and hour of death of the first 67 cases were collected, but no mention is made of where they came from. Food and medicines were dropped at the cordon, miles away, and no means provided to get them, as the railroads stopped running. Then the most deaths were found to be in the center of the town, where the narrow streets prevented the northwest wind from coming, and where there was very little ventilation or wind at all; 400 dead cattle were taken out of the river. It was found that the cordon was daily evaded by the natives, large numbers of whom had left the town, and the disease was traveling southward. Many Greeks and Syrians also escaped, and went down to Cairo and up to Alexandria. The houses even of the notables were found in a most disgraceful state of filth, and some of the owners were fined or imprisoned; diarrhœa became common but not very fatal. The air was very hazy, and cholera was supposed to dwell in it. Many cases died in a few hours without previous diarrhœa or vomiting. A great many soldiers forming the cordon were attacked; the sentinels stationed in the cemetery were seized.

Dr. Mackie said the study of the outbreak epidemiologically, commercially and politically was of the most intense interest; and the investigators would have to be very independent men, entirely free from all political influence if the truth was to be arrived at. Scarcely a case of true cholera had occurred in Egypt since 1866. Young doctors and disinfectants were sent to Mansourah, but to disinfect an Egyptian town so as to stop cholera was like pouring a bucketful of water into the sea to float a stranded vessel. To disinfect such towns, they should be destroyed by fire. The only hope was in the rising of the Nile. As soon as cases occurred in a village, the inhabitants fled to prevent being shut in by a cordon; eight doctors and forty-four hospital assistants were sent from India. From July 11th to 17th, 428 died in Mansourah, and their bodies were buried in shallow brick tombs only fifty to sixty centimetres deep; and no earth or quicklime was used. People began to seize each other's tombs, and then the owners would come, drag out the strange bodies, and leave them on the open ground. The corpses of the best people were washed, wrapped in a new sheet with camphor, and carried to the tombs in public coffins and then put without a coffin in the shallow and cracked brick tombs, from which bad smells and gases of decomposition arose. The public coffins were then purified. Calm hot days increased the mortality; fresh winds even from the northwest lessened it. There was an almost miraculous coincidence in the rapid decrease of the epidemic with the first rising of the waters of the Nile. There were many large inclosures filled with ruins, and great heaps of refuse. Dry clean sand was spread over the streets. The latrines of the mosques and public baths were nailed up; but the sewers emptied into the river, and many wells were filled with fæcal matter. Interments generally took place in the midst of the towns. In less than one month there were exactly 1,999 deaths (they could not make it 2,000 without lying) from cholera in Damietta, of which 1,998 were Egyptians; 1,952 were poor, only 47 rich; 1,698 died in the city, 301 in the suburbs; 997 were males, 513 of whom were children, 1,002 were females, among them 414 children; only 10 were foreigners.

The Port Said cases are said to have commenced June 23d, and to have been brought from Damietta, which only acknowledged the disease on the 22d. Dr. Flood sent all the cases to hospital, emptied, disinfected, and whitewashed the infected houses, locked them up for twelve days, and thus stamped out the disease at Port Said. He was familiar with cholera, and unhesitatingly pronounced it Asiatic. The wind was dry and cool, 24° to 29° Cent.

The typhoid stage of cholera was mistaken for typhoid fever and the disease pronounced by others as malarious, or else coming from the cattle plagues. In a large lodging-house in Alexandria an old lady was taken with cholera and all the inmates fled, not from fear of the disease, for they offered to stay and nurse her provided they would not be sent up and quarantined for an indefinite time.

Surgeon-General Hunter only commenced his investigations into the origin of the epidemic on Aug. 8, 1883. Cholera arrived at Cairo July 15th, brought there by refugees who fled from Menzaleh before the cordon was formed. The city was filthy; the dead were covered with shawls, which were afterward worn by the relatives. There were 764 deaths the first week, 2,438 the second week, which was heavier than in 1865, when there were only 205 and 1,919. Boulak and old Cairo suffered most severely. The people lived in mud hovels, eight feet by eight feet and only six feet high, with five, six and seven persons in each; together with sheep, poultry, and small cattle. The natives are low, dirty, and even filthy. The temperature was from 28.7° to 30.7° Centigrade; barometer 755 to 753; hygrometer 38.35 to 46.76. The prevailing winds were from northeast to north. They were west in 1865. The vice-consul said the sparrows did not fly away but chirped merrily all during the cholera; the flies and mosquitoes stayed also. The sky was azure, pure and light; there was no heavy lead or any other grim colored atmosphere. The disease was not in the air but in the people and their filth, and in the water. Cairo has 367,000 inhabitants.

August 6, 1883, Shibin el Kom, with 16,000 inhabitants had had 1,000 deaths from cholera. Damanhair Tantah, Zagazig and Rosetta were attacked later. The epidemic followed the east branch of the Nile from Damietta; it was only recently that the western or Rosetta branch was involved. Alexandria as yet had escaped with a few isolated cases; but villages on the Mahmoudieh canal, which supplies it with water, were now attacked. Ghizeh, two miles from Cairo, had 800 deaths. It was remarkable how little the rest of Cairo, except Boulak and old Cairo, had been affected. They are on the river Nile, and lost 24 to 30 per thousand; the rest of the city only 8.73 per thousand. The six quarters of Cairo farthest from the river only had 20 deaths a day, out of 163,844 inhabitants. The Nile water was evidently at fault.

Eleven more villages had from 10 to 20 deaths each; 31 more from 1 to 7 each. Up to August 8th, Cairo had lost 5,249. The tombs, or brick shells, were opened again and again for fresh corpses. The burying was as bad as could be, scarcely two feet under ground. At Mansourah fifteen or twenty bodies were often lying on the ground, waiting burial and relatives and many friends standing around. There were over 2,000 refugees in the town, and the shops were out of provisions.

Alexandria gets her drinking water from the Rosetta Nile at Asfeh, thence through the Mahmoudieh canal, 21,000 tons daily; population 210,000. Alum iron was used to purify this water. The bombardment of the town had left many open spaces, and freer ventilation; the sewerage was pumped out into the bay. By Aug. 6th there had been 16,117 deaths in Egypt. In Damietta most of the hut dwellings were underground cellars, like mere cesspools; or were huts made of straw, mud with cow-dung for mortar. Fish and rice were the general food.

Much water was kept in cisterns, filled from the Nile when in high water. There were cemeteries all around the town like a belt; the streets were defiled with fæcal filth. Cholera broke out in the most crowded and unhealthy part of Damietta suddenly on June 22; the mouth of the river was dried up by a long drought. Thousands of carcasses of animals lodged on the banks and the drains emptied there; there was miasma from the rice fields. This water was used by 15,000 strangers, who went into veritable orgies. The epidemic broke out just at the end of the fair, when great heat set in. The water contained putrescent matter and vibrios.

Surgeon-General Hunter reviewed the whole ground, and says the tombs were hollow brick structures 6 feet by 4, with a hole at one end to push in the bodies—when full they were bricked up. The village barber is the first register of vital statistics; he shaves the corpse and takes down what the relatives tell him was the cause of death, and then he grants a burial permit.

Egypt has only had five epidemics of cholera, viz., in 1848, 1850, 1855, 1865 and 1883. Filth diarrhœa is common and fatal; but only one or two cases a year of cholera-morbus or cholerine occur. A boy, aged 5, died of cholera at Damietta on June 19th. Another case happened as early as May. Two Greek children also died on April 27th. A barber died of cholera at the end of April. One case of cholera was drummed up in 1867, and another in 1873. There were one or two cases only of cholera morbus every year; rarely more. A tobacco seller died May 13th. In 1881, 1,889 died of dysentery in Cairo; 1,097 of gastric and typhoid fever. In 1882, 1,993 died of dysentery and 1,472 of gastric and typhoid fever. The cholera came practically to an end on Sept. 11th. The outbreaks in 1865 and 1883 both took place at Karmoose, the most unhealthy part of Alexandria.

Surgeon McNally showed that diarrhœa and vomiting had prevailed at Zagazig ever since January, 1883, and had been fatal to 200 persons: that great mortality had been at Chibin el Kom prior to the report of the cholera at Damietta; also in villages near Benha, with more than fifteen deaths a day. Chevalier said cholera had been in Upper Egypt six years before.

At Mahallet el Kebeen cholera was not reported till July 10th, but numerous cases occurred before that date; diarrhœa was common and intractable; on one day twenty-nine died of cholera.

Another says cholera always follows cattle plague.

Dr. Hunter thinks it has been endemic in Egypt since 1865, because a few cases of cholera morbus occur each year.

Dr. Mahé thought cholera was introduced by coalers and stokers on steamships running between Bombay and Port Said.

Dr. Hunter also makes the extraordinary statement that cholera has never been imported from India to Egypt or Europe ! ! or any other country, and adds, in no case can cholera be proved to have been imported from India; and in every alleged instance of importation the allegation has failed to bear examination. He says there were only 192 deaths from cholera in Bombay in 1882, against 529 in 1881, and 120 from the first six months of 1883.

Lewis and Cunningham found a rapid development and multiplication of bio-plastic bodies in the blood, but could not inoculate animals with fresh excreta nor with those 22 days old, and no other person can; the one is too fresh and the other too stale.

All the early records in Damietta were lost by the death of the principal barber who acted as the registrar of vital statistics.

Dr. S. V. DeCastro concludes from his study of the cholera in Egypt in 1883[1] that the disease was most probably imported from India. He says that while this cannot be proven with certainty, it is much more probable than all the other hypotheses put together which have been advanced as to the origin of that epidemic. He thinks that hygiene of cities, houses and individuals is the most effective means in our power to prevent the spread of cholera. E. C. W.

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[1] Cholera in Egitto nel 1883, sua Origine e Misure igieniche e quarantenarie. Milan, 1884.

CHAPTER XI.

CHOLERA IN FRANCE, ITALY AND SPAIN IN 1883 AND 1884.

It was generally supposed that no cholera escaped from Egypt into Europe, but that all was carried back by refugees from Damietta south into Egypt toward Arabia. Damietta has so little commerce with Europe that this was to be expected; although the shipping from Alexandria is very much less than before the opening of the Suez canal in 1869, still there was much more danger from it, especially to France. We now know that there was a small epidemic at Marseilles in 1883, which was carefully concealed; the doctors and nurses having been sworn to secrecy by the authorities. Where this cholera came from is not yet positively known, whether from Tonquin, China or Egypt, as the particulars are still purposely shrouded in darkness.

The first we heard of cholera in France for a long time was at Toulon early in June. Transports from Tonquin with the disease arrived, and its presence was concealed for at least three weeks, until it could be hidden no longer. Then all the early records were not only lost, but shamefully concealed. The consequence was the tremendous panic with which all are familiar. At least 10,000 or 15,000 Italian laborers fled from Toulon, some to Marseilles and many more to their homes in Italy. The epidemic broke out in Marseilles so soon after it was announced at Toulon, that some doubt has been raised whether there was a recrudescence from the fall epidemic, or whether it was brought from Toulon. The earliest cases seemed to be in refugees from Toulon; but no one knows whether still earlier cases were concealed until the blame could all be put on Toulon. Cholera had been so prevalent in the French army and fleet at Tonquin, that their operations were seriously interfered with, and of course the French authorities concealed all they could about it for political and military reasons. But infected transports did come to Toulon. The same panic arose in Marseilles, and at least 10,000 or 15,000 more Italians fled to Italy.

In the lower part of Toulon the water supply is scanty and bad, and much runs from the fountains in the upper part into the gutters in the lower part and down to the harbor, which is land-locked, almost tideless, and so very foul that typhoid fever prevails largely at almost all times. The lower Toulonese also have no privies, but empty their chamber-pots into the streets and gutters every morning, and throw out all their garbage there also. The market people were seen freshening their vegetables by dipping them in the gutter water.

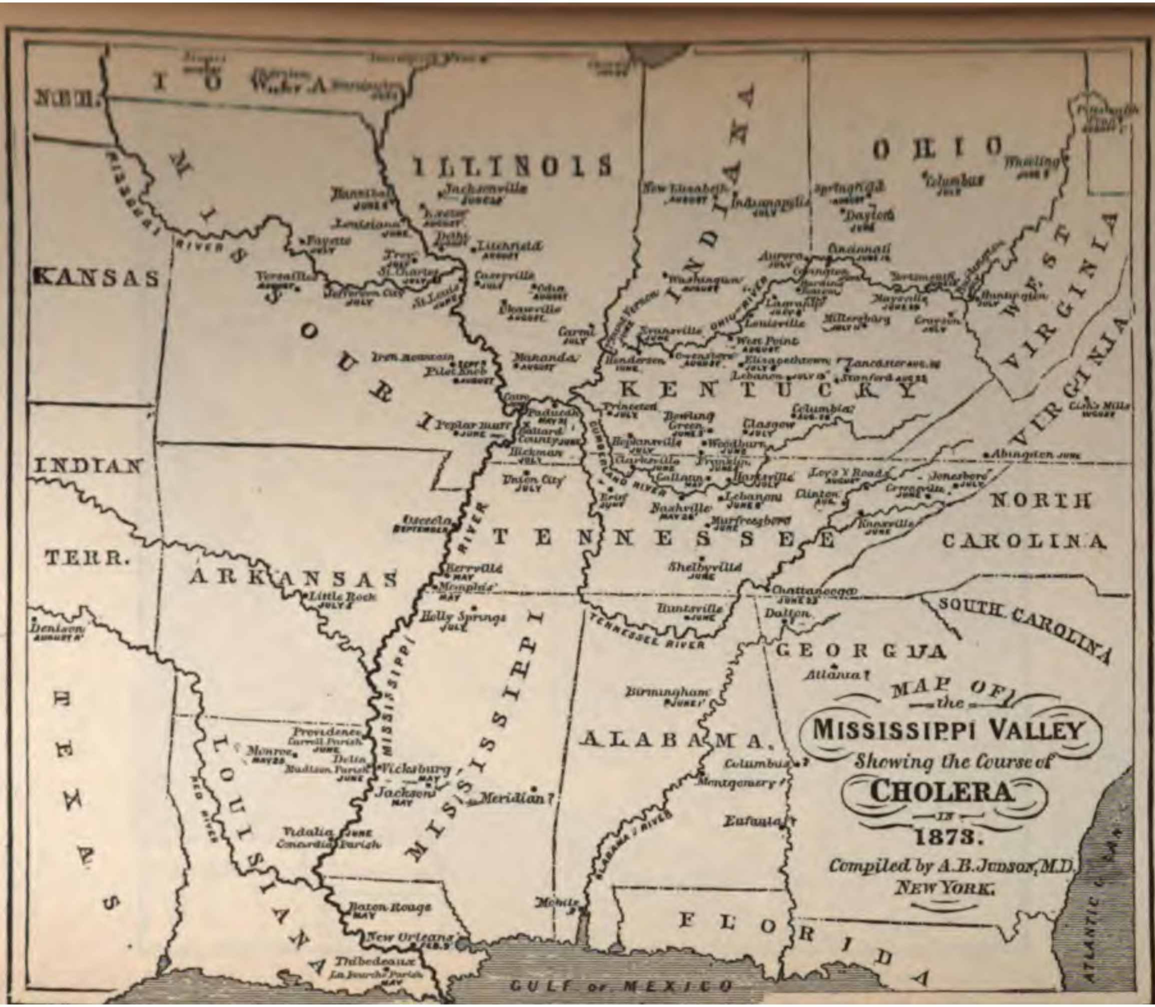
The water supply of Marseilles is abundant and good, but the gutter water from numberless fountains was used as in Toulon. Not much cholera was carried north, but a few scattering cases occurred in Paris every month. Still as they did not at once reach the water supplies there was no extended outbreak until September, and even then the deaths scarcely reached 1,000. It was stopped more by the advent of cold weather than by any other cause.

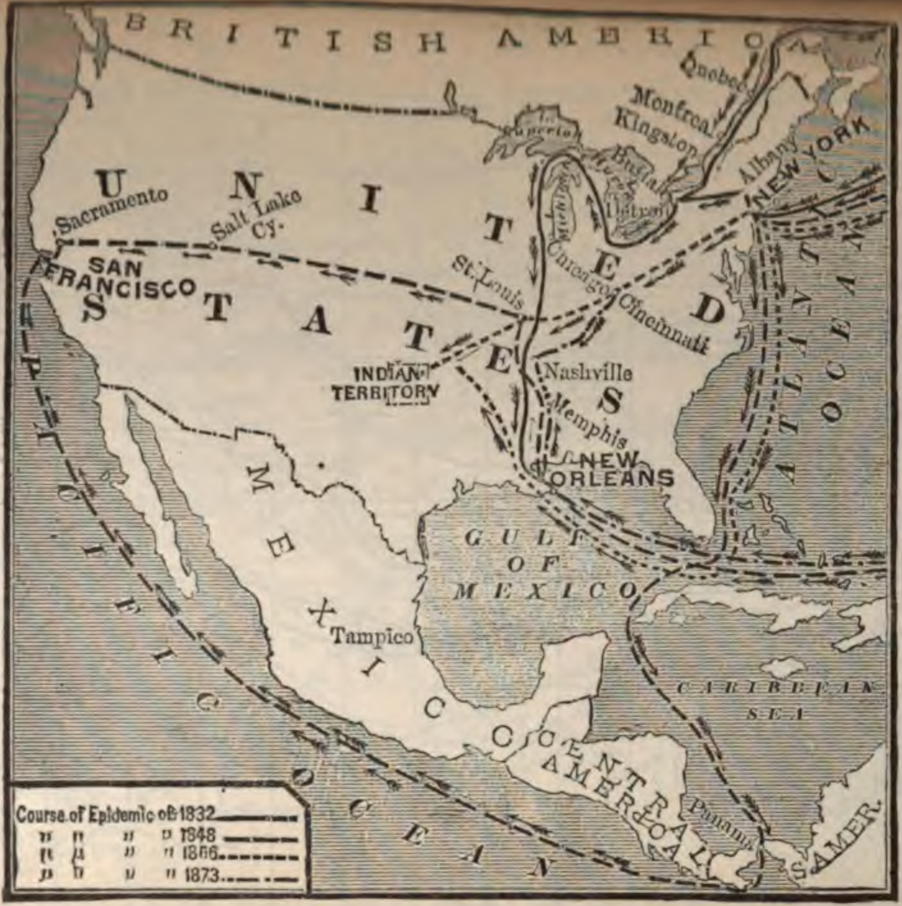
The quarantine on the northern border of Spain was so severe that little pestilence got over the boundaries. But a family from Marseilles, wishing to escape quarantine, went down to Algiers, where there was no cholera yet, and sailed for Alicante on the east coast of Spain and started an epidemic there.

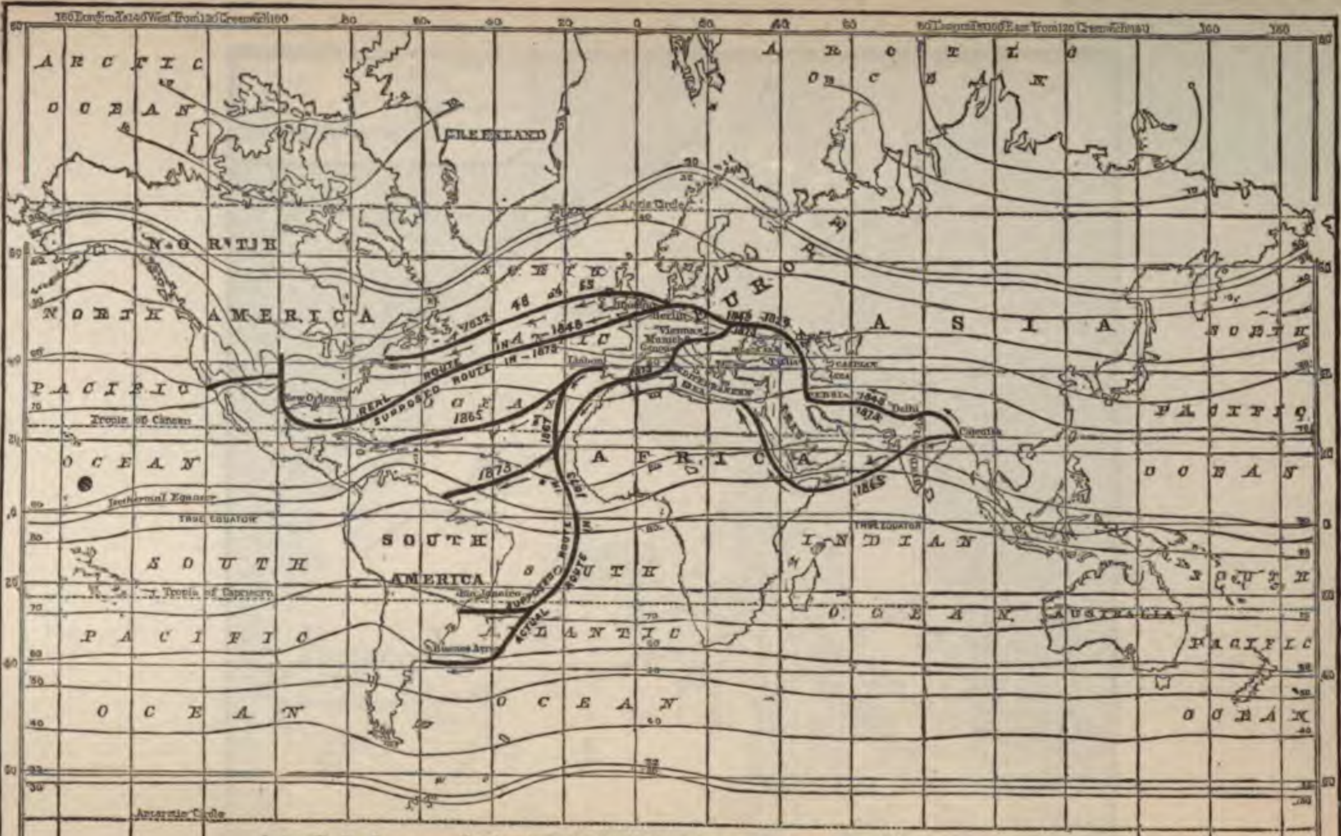
The Italian refugees from France slipped through the mountain passes and brought the pestilence to the most western provinces of Italy, viz. Turin and Cuneo. The Italian government sent transports to carry off others, which were landed principally at Genoa, Massa Carrara, further down the west coast, and especially at Naples. No less than three great importations took place at Naples. At Genoa cholera discharges are known to have got into the water supply. At Naples, in addition to the horrible filth of the affected parts, surface wells were largely in use, and only too often became contaminated from the *pozzis* or privies with which each house was supplied, and which when full overflow into the street gutters. The general water supply of Naples is scanty and bad. Rome refused to receive any refugees and escaped pestilence. Ultimately it came out that almost every really malarious city and province in Italy escaped cholera, while many of the non-malarious towns were heavily attacked. I first drew attention to this fact by examining the large official map of the malarious districts of Italy.

The epidemic cost France and Italy 40,000 or 50,000 lives and many hundreds of millions of money. The loss of the latter is still going on, and will go on until it is proven that there will be no recrudescence of the pestilence this summer. The travelers to Italy and France have been few this winter, and will be far fewer this whole year.

Scattered cases occurred in Paris until the suburb of Aubervillier, in the extreme northeast, was involved, and cholera discharges got into the canal St. Denis, which empties into the canal de L'Ourcq. Dr. Roux calculates that one-fourth part of all the fæcal matter of Paris is swept down the river Seine to the north, beside that which is carried to the great poudrette works. In all the great epidemics in Paris the heaviest stress of the pestilence has fallen upon the districts supplied with river Seine water and that from the canal L'Ourcq, which is distributed without filtering for drinking and cooking water. Of course contagion or infection from case to case could rarely be proved, except in hospitals and asylums where it was manifest. The disease was attributed to miasma; but the air had to traverse the whole southern and central parts of Paris, which it did without causing cholera, in order to reach the northern arrondissements, where cholera finally broke out after a few cases got there and contaminated the water.


MAP OF
the
MISSISSIPPI VALLEY
Showing the Course of
CHOLERA
IN
1873.
Compiled by A.B.Judson, M.D.
NEW YORK.
NEB.
IOWA
KANSAS
INDIAN
TERR.
TEXAS
MISSOURI
ILLINOIS
INDIANA
OHIO
WEST VIRGINIA
VIRGINIA
KENTUCKY
TENNESSEE
NORTH CAROLINA
SOUTH CAROLINA
GEORGIA
ALABAMA.
MISSISSIPPI
ARKANSAS
LOUISIANA
FLORIDA
GULF OF MEXICO
ATLANTIC OCEAN
MISSOURI RIVER
MISSISSIPPI RIVER
OHIO RIVER
CUMBERLAND RIVER
TENNESSEE RIVER
RED RIVER
ALABAMA RIVER
Hannibal JUNE
Jacksonville JUNE
Louisiana JUNE
Fayette JULY
Versailles AUGUST
Jefferson City JULY
St. Charles JULY
Troy JULY
St. Louis JUNE
Litchfield AUGUST
Carrollton JULY
Carmi JULY
Makanda AUGUST
Iron Mountain
Pilot Knob AUGUST
Cairo
Poplar Bluff JUNE
Paducah MAY
Ballard County JUNE
Hickman JULY
Union City JULY
Osceola SEPTEMBER
New Elizabeth AUGUST
Indianapolis JULY
Washington AUGUST
Mount Vernon
Evansville JUNE
Henderson JUNE
Owensboro AUGUST
Springfield AUGUST
Columbus JULY
Wheeling JUNE
Dayton JUNE
Cincinnati
Aurora JULY
Covington
Louisville
West Point AUGUST
Elizabethtown JULY
Lebanon JULY
Lancaster
Stanford
Maysville
Millersburg JULY
Grayson JULY
Portsmouth
Huntington JULY
Princeton JULY
Bowling Green JUNE
Glasgow JULY
Columbia
Hopkinsville JULY
Woodburn JUNE
Clarksville JUNE
Franklin JUNE
Gallatin MAY
Hartsville JULY
Lebanon JUNE
Nashville MAY
Murfreesboro JUNE
Shelbyville JUNE
Abingdon JUNE
Jonesboro JULY
Greeneville JUNE
Clinton AUG.
Knoxville JUNE
Chattanooga JUNE
Dalton
Atlanta?
Huntsville JUNE
Birmingham JUNE?
Columbus?
Montgomery?
Eufaula?
Mobile?
Little Rock JULY
Denison AUGUST
Memphis MAY
Holly Springs JULY
Providence Carroll Parish JUNE
Monroe MAY
Delta Madison Parish JUNE
Vicksburg MAY
Jackson MAY
Meridian?
Vidalia Concordia Parish JUNE
Baton Rouge MAY
New Orleans FEB.
Thibodeaux La Fourche Parish MAY

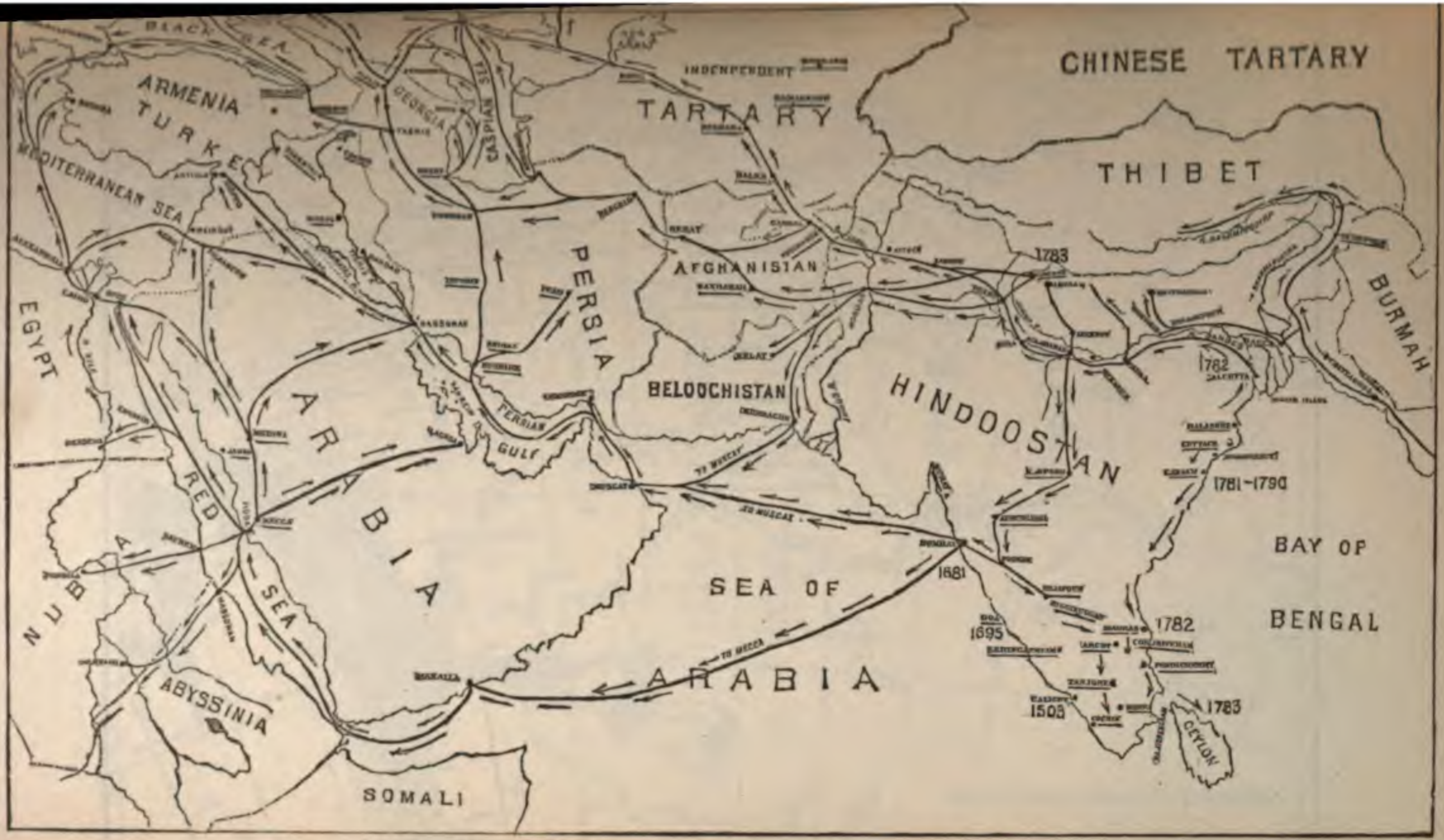

BRITISH AMERICA
UNITED STATES
Sacramento
Salt Lake Cy.
SAN FRANCISCO
St. Louis
Chicago
Cincinnati
Quebec
Montreal
Kingston
Buffalo
Albany
NEW YORK
INDIAN TERRITORY
Nashville
Memphis
NEW ORLEANS
ATLANTIC OCEAN
GULF OF MEXICO
MEXICO
Tampico
CARIBBEAN SEA
CENTRAL AMERICA
Panama
S. AMER.
PACIFIC OCEAN
Course of Epidemic of 1832
" " " " 1848
" " " " 1866
" " " " 1873



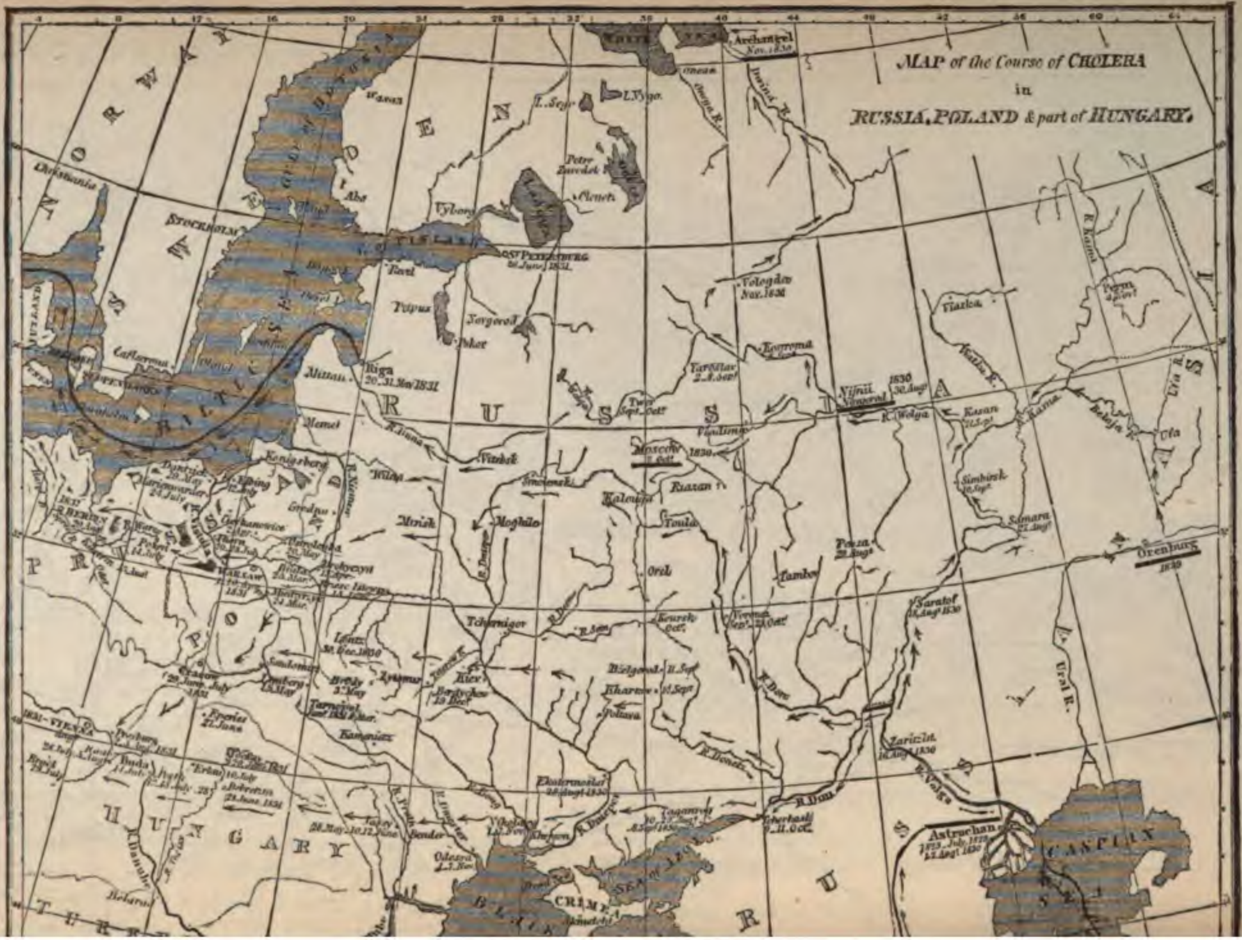
Actual & Supposed Routes of CHOLERA from HINDOOSTAN to EUROPE
and to
NORTH & SOUTH AMERICA IN 1832. 1848, 1854, 1867, 1873.
by JOHN C. PETERS, M.D.

The waved black lines are the Isothermals.
The numerals at their extremities indicate the
[illegible]

Cholera has followed the routes of travel
and not the isothermal lines.



Routes of Cholera from India to Asia, Africa and Europe. *By* Dr. John C. Peters.



MAP of the Course of CHOLERA in RUSSIA, POLAND & part of HUNGARY.

SECTION II.

A HISTORY OF EPIDEMIC CHOLERA, AS IT AFFECTED THE ARMY OF THE UNITED STATES.

BY

ELY McCLELLAN, M.D.,

MAJOR AND SURGEON U. S. ARMY.

CHAPTER XII.

GENERAL REMARKS AND THE EPIDEMIC OF 1832 TO 1835.

General Remarks.—Ten years ago, in a history of the cholera epidemic of 1873 in the United States, I formulated the experience which was attainable from that epidemic, in a series of propositions which, although they excited a storm of adverse criticism have survived the lapse of a decade to be strikingly verified by the experimental research of Koch and other observers.

It has been shown that cholera is constantly diffused over extensive areas of territory by the movements of individuals; that troops and camp-followers have at times been active agents in such diffusion. It is a well-established fact that cholera being epidemic in a country occupied by troops, the disease almost inevitably appears among them, and that by their movements the epidemic area is extended.

The history of cholera outbreaks among troops and the agency which troops have exerted in its diffusion in times past, is of value as indicating not only what may be expected in future epidemics, but what sanitary precautions should be adopted by which a repetition of such histories may be prevented; for the history which will hereafter be presented fully demonstrates the fact that epidemic cholera will develop at any locality to which the specific poison of the disease may be carried, and *in which it finds a suitable hot-bed for its prolification.*

THE EPIDEMIC OF 1832 TO 1835 AMONG TROOPS.

In the spring and early summer months of 1832 a series of military movements commenced against the Sac and Fox Indians, who were led by Black Hawk; and an army composed of troops serving along the Mississippi frontier, the Atlantic coast, and Western volunteers, was ordered to the field. On the first day of July seven companies of infantry destined for this campaign were embarked on the steamer Henry Clay at the city of Buffalo, New York State. The Henry Clay, prior to her being chartered as an army transport, had been engaged in the emigrant service. By adverse winds the boat with her living cargo was detained at Buffalo until the morning of July 3d, when she sailed for Detroit. July 4th, cholera broke out among the troops, and before she arrived on July 5th, two cholera deaths had occurred. When the Henry Clay arrived in the Detroit river. the steamer Sheldon Thompson had but a short time preceded her, having on board General Scott and staff, six companies of artillery and two of infantry troops. The garrison of Fort Niagara, consisting of 78 men, had arrived at Detroit on the 30th of June, and were quartered in an old brick building on the banks of the river, in the most filthy part of the town. They had been conveyed from Buffalo, N. Y., to Detroit by steamboat.

The disease spread with frightful rapidity on the Henry Clay, and on July 7th the troops were landed one mile below Fort Gratiot on the St. Clair river. Two days later it is reported that owing to the virulence of the epidemic, by deaths and desertions among the panic-stricken, the seven companies which had left Buffalo but five days before were reduced to a total of but sixty-eight (68) men. A large number of deserters from the camp are reported to have died from cholera in the surrounding country, many on the roadside. July 8th, cholera appeared among the troops from Fort Niagara; the same day two men who had been employed to communicate with the steamer Henry Clay died of the disease in the city of Detroit, and the authorities of that city having become alarmed, demanded the removal of the troops, who were accordingly ordered to the camp below Fort Gratiot. The steamboat Sheldon Thompson being free from the disease, on the 6th of July proceeded on the journey and arrived at Fort Mackinaw. On the evening of the 7th, cholera having developed among the troops on the voyage, four cases were sent to hospital. All proved fatal. July 8th, no other cases of cholera occurring, the Thompson proceeded on her voyage; the next day twenty-one (21) cases of cholera occurred, and when on the night of July 10th she reached Chicago, there had been a total of seventy-six (76) cases and nineteen (19) deaths.

By order of General Scott the uninfected garrison of Fort Dearborn was marched into camp some two miles distant. The fort was converted into a cholera hospital. At Fort Dearborn the disease was, if possible, more virulent than it was at the camp near Fort Gratiot; it spread in the (then) village of Chicago, and was carried into the camp of hitherto uninfected troops (garrison of Fort Dearborn) the first cases therein being in the persons of soldiers who in direct violation of orders had visited Fort Dearborn. The senior medical officer reported that previous to the arrival of the Sheldon Thompson "there was not a case of disease of any kind at the fort or village."[1]

Throughout the month of July the disease continued, and so disastrous were its consequences that the general commanding the army (Macomb) states in that portion of his report which relates to the Black Hawk War: "Unfortunately, however, the cholera was just at this time making its way into the United States from Canada, and infected our troops while on board the steamship in their passage up the lakes, and such was the rapidity with which the disease spread among them, that in a few days the whole force sent by the lakes was rendered incapable of taking the field. Some were landed at Fort Gratiot, others were stopped at Detroit, while the principal part reached Chicago in a most deplorable condition."[2]

On the 1st of August, the officer commanding at Chicago reported that the disease was subsiding; that no deaths had occurred in the last sixty hours, and that very few new cases had occurred. The remnant of the troops from Fort Gratiot and numbers of deserters from that camp reached Chicago in the early days of August. By the 13th of August cholera had disappeared from among the troops camped at Chicago, and the march for Rock Island was commenced.

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[1] The medical officer reported "at the time it was generally believed that the principle of infection existed in the steamboat in which the troops were conveyed from Buffalo to Detroit, the vessel having been employed in transporting crowds of filthy emigrants westward from Montreal and Quebec. The Henry Clay, among the troops on board of which the disease also appeared, had been engaged the same kind of service."—Medical Statistics U. S. Army, 1840, p. 91.

[2] Medical History of the Army, 1840, p. 81.

At Chicago, the northwest spread of the epidemic would have been undoubtedly arrested had the wise orders of General Scott been obeyed; but, as if to demonstrate early in the first American epidemic the agency of individuals in the diffusion of cholera, a most flagrant disobedience of orders occurred, and as a result another body of troops were infected, the disaster of Chicago was reënacted at Rock Island, and epidemic cholera was spread over a great area of country.

The violence of the epidemic subsiding, on the 29th of July General Scott left Chicago and crossed the country to Prairie du Chien, on the Mississippi, where he met Brigadier-General Atkinson, with the troops under his command, returning from the Bad Axe River, where he had routed the Indians under Black Hawk on the 3d of August, and had effectually closed the war. No cholera had occurred among the troops in immediate attendance upon General Scott after leaving Chicago. He, joining the command of General Atkinson, descended the river to Rock Island, where the regular troops were encamped at or near Fort Armstrong, on Rock Island, which post had been abandoned for some time. The volunteer troops were already on the homeward march.

It was a matter of the greatest solicitude to General Scott to prevent the meeting of any troops who might be on the march from Chicago and the returning volunteers. It was equally a matter of solicitude on his part to prevent four companies of Rangers, then being raised in the counties adjacent to the Ohio, from contact with Chicago or the troops who had suffered so severely at Fort Dearborn. The report of General Scott so clearly defines the impression which experience had graven upon his mind of the necessity of isolating those who were infected with cholera from those who had not been exposed, that I reproduce extracts from his report to the Honorable the Secretary of War.

HEADQUARTERS NORTHWESTERN ARMY, ROCK ISLAND, September 1, 1832.
SIR:

* * * * * * * * *

"The *manner* of the introduction of this disease among the troops which had been serving under the immediate orders of Brigadier-General Atkinson is to me an affecting speculation.

"I have already reported many of the measures adopted by me to prevent the spread of the disease from that place [Fort Dearborn, Chicago] among the inhabitants of the country, volunteers, and United States Rangers; but I have not reported half of my care and solicitude on the subject, nor is it possible for me to do much more on the present occasion. I left Chicago on the morning of the 29th of July. The disease among the troops there, as we all thought, had nearly exhausted itself.

* * * * * * * * *

"I hastily addressed a letter of instructions to Colonel Eustis, second in command, of which the following are extracts:

"'From a letter just received from the Secretary of War, I find it is his opinion, on account of cholera, that the movements of detachments infected with that disease should not be precipitated. You are fully aware of my own policy to guard against the spread of the calamity. I shall therefore leave you the same discretion (to march or not to march) which I have heretofore exercised myself on that critical subject; but hope by the arrival of Lieutenant-Colonel Cummings' small detachment, if not before, it may be deemed safe, in respect to humanity and the good of the service, for you to take up the line of march.

"'You will, as long as new cases of cholera shall happen to occur here or on the march, take all proper measures to avoid a junction with Rangers or volunteers, but long before you reach the Mississippi I trust your battalion will cease to be suspected of cholera.

"'I have kept you up to this time so fully acquainted with my correspondence and views, with all authorities and on all subjects, and my confidence in your intelligence, zeal and abilities is so great, that I deem it superfluous to say more to you at present. I know well that I leave the public interests in safe and able hands.'

"By the misconduct of two express riders (one of whom lost his dispatches) I did not hear from Colonel Eustis, after he left Turtle River, till the night of the 21st ultimo, when a part of his troops in boats were actually at the mouth of Rock river, three miles below. His letter was dated the 16th of that month, at Dixon's ferry. He arrived himself by land, near the mouth of Rock river, the same night (with the remainder of his troops) that I received his letter. On the morning of that day I stated to you that 'a few old and lingering cases of cholera were on the boats.'

"This was founded on rumor, and was a mistake. On visiting his camp, on the 22d, I had the happiness to learn that there had not been a new or old case of cholera among his troops after his passage of Turtle river on the 13th ultimo, one hundred and thirty or one hundred and forty miles from this. I, nevertheless, by order, confined his troops to an island in Rock river, and interdicted all communication, except by my special permission, between his camp and the other troops, or inhabitants of the neighborhood; that is, one family, a mile above him, on another island, and one family on this side of Rock river. Neither of these families, as far as I have heard, has been infected, nor was there a single case of cholera in his camp down to last evening. Myself, an aide-de-camp and one other officer were the only persons who had visited that camp from this island, and neither of us has been infected.

"On the 12th ultimo I caused a letter to be addressed to Colonel Eustis (which he acknowledged at Dixon's Ferry on the 16th), of which the following is an extract:

"'The general is very desirous that you should take great pains to avoid all communication, either with the inhabitants of the country or with other troops, should any new case of cholera have occurred on the march.'

"This was written when I knew that the volunteer militia would be returning home by Dixon's ferry, and that certain companies of the United States Rangers might be expected there on their way to join me. I believe the volunteers returning home had all passed to the east before Colonel Eustis arrived, but he met or found there Captain Ford's company of United States Rangers, and it is known that some communication personally took place between the *officers* of the two bodies, if not between their *men*, as well while near Dixon's as afterward, on their march hither, Captain Ford following the trail of Colonel Eustis at a distance generally of eight or ten miles till the latter encamped on an island in Rock river, and then the former crossed a half-mile above. These facts are by others deemed important as to the introduction of cholera here, but not by me, though they certainly show a neglect of my repeated instructions. Colonel Eustis, always a non-contagionist, had, on reaching the ferry (Dixon's), been three or four days without a case of the disease, either new or old, and, therefore, became too confident that his officers and men could not impart it to others.

"But Captain Ford's company, which has clearly infected this island, and through it will, I fear, infect the whole valley of the Mississippi, in all probability imbibed the contagion at Chicago. At that place, and on my way westward, I had filled the whole country south and east, through newspapers, by innumerable letters (four of which were to the four captains of Rangers on this side of the Mississippi), through discharged volunteers on the Illinois and Rock Island rivers, and other means, with admonitions to Rangers not to approach Chicago. I had sent the arms of the four companies to Danville and Dixon's ferry in the same view, and informed each captain where to find his own, and to give like information, if he could, to the three others. These letters were all left unsealed, and indorsed with my rank and name to excite curiosity, and to induce postmasters and others to read them and give publicity to my admonitions. In short, I had erected a paper barrier around Chicago which no company of Rangers, though ordered to report to me there, could ignorantly pass. In the mean time, and down to the arrival of Captains Boon and Ford here, I had not received a line from either of the captains, except Brown, who was recruiting at Danville.

"Captain Ford, on his march from the Ohio river, did not ignorantly pass the barrier I have mentioned. On his arrival at Captain Orr's camp on Hickory Creek, thirty-five miles from Chicago, he learned from the latter (an excellent officer) my solicitude on the subject of cholera. He had seen one of my published letters to the same effect. Nevertheless, with fourteen of his men, he went up to Chicago for provisions, and suffered himself, with some of his men, to be coaxed into Fort Dearborn. This was about the 10th ultimo. Twelve days afterward Captain Ford's company arrived here, and on the night of the 25th ultimo sent a sick man (Johnson) across into Fort Armstrong, who has proved to be a case of cholera, and is the first on this island. This man was one of those who went up to Chicago, and, if not into Fort Dearborn, was certainly at the entrance of the cholera hospital, then reeking with recent disease.

"The second case and first death was another man (Hall) of the same company. He was brought into the hospital here and died on the 26th.

"Here again I have had all my care and sagacity singularly defeated by accident or ignorance. I had visited Captain Ford's company camp, and, on seeing two of his men sick of fever, directed that cases requiring care in the treatment should be sent to the hospital in Fort Armstrong. I was then ignorant that any part of the company had been near Chicago or had any intercourse with Colonel Eustis's command at Dixon's Ferry. The day that Johnson was sent over to this island, Captain Ford told me that he had a third man sick of *common cholera*, whom he wished to send to the hospital. Being about to leave the fort for Colonel Eustis's camp, I directed one of the surgeons here to keep watch for that man at the water's edge, in order to see if the case were not one of spasmodic cholera, and if so, not to permit him to be landed. Dr. Coleman had never before seen a case of that sort, and received Johnson through a very natural ignorance. The disease not being early developed, I myself, on repeated inspections doubted its character until after I had the honor of addressing you on the morning of the 26th, and therefore did not mention it. So afterward, on the 26th, another ranger (Hall) was introduced. He was received by the other surgeon, Dr. Smith, after a similar caution from me, and died in a few hours of cholera. We had but one case, a man of the Fourth Infantry, on the 27th, who lay in the hospital (a case of debility) with Johnson on the night of the 25th. On the 30th the disease began to rage among all the troops on this island. Strange to say, that not another case occurred in the camp of rangers (on the west side of the Mississippi) from the 26th down to this morning. Two more are now reported, and I fear that the usual havoc will follow among the drunken and feeble. * * *

"SEPTEMBER 2.

"During the panic on the night of the 30th, seventeen men of the Sixth Infantry, who mostly have families at Jefferson Barracks, stole a boat and deserted. It is supposed they have gone thither. *Many of them will probably perish by the way and the remainder infect the barracks and St. Louis.* On the morning of the 29th at daylight, I sent off by water, under guard, seven prisoners, five of whom were principal chiefs or warriors of Black Hawk's band, to be confined as hostages at Jefferson Barracks during the pleasure of the President of the United States. This measure was taken on the night of the 28th, after consulting Governor Reynolds who was present), and with his concurrence. I at the same time delivered up to Ke-o-kuck and other friendly chiefs then here all the old men, the women and children who were under guard as prisoners of war, and sent the whole away.

"These precautions were taken in haste, before the cholera had spread beyond the third case, which happened on the 27th, and when we hoped that neither the guard of the hostages nor any Indian sent away had imbibed the disease. The rapid spread which commenced on the night of the 29th has given us great uneasiness on this point. We had remaining the three murderers of the Menomonees, the murderer of one of our citizens near the Yellow Banks, and some young men whose quality we had not ascertained. Two other warriors were brought up from the friendly villages below, on the 29th, after the hostages were gone. Of these Indians four were already reported as dead of the epidemic and several others were sick.

"I have the honor to be, sir, with great respect,

"Your most obedient servant,

"WINFIELD SCOTT.

"Hon. LEWIS CASS,
"Secretary of War."

On the 16th of September, it was officially reported that cholera had entirely disappeared from among the troops on Rock Island, and that it was fast subsiding in the camp of the Rangers on the west side of the river.

On the 10th of September, it was reported that at Jefferson Barracks, Missouri, the cholera was epidemic. At this post on September 4th a party of deserters, fifteen (15) in number, from Rock Island, arrived and surrendered themselves, stating that they had deserted from the cholera alone; and they were followed by other deserters who had descended the river in canoes. Of such a party Surgeon McMahon reported that on the 9th of the month one man had been brought ashore "in the last stage of collapse."

From Jefferson Barracks the disease was carried into the city of St. Louis; and at a later date by two companies of Rangers (Boone's and Ford's) to Forts Gibson and Smith in Arkansas. From St. Louis cholera was carried on steamboats down the Mississippi river, and up the Ohio river, where at Cincinnati it met lines of infection which had crossed from Erie to Pittsburgh, Penn., and from Cleveland to Cincinnati, Ohio. From Cincinnati a broad trail of infection crossed into and through the State of Kentucky, thence through the State of Tennessee to the city of Memphis, where it joined the course of river infection and descended upon the city of New Orleans, in which city six thousand (6,000) deaths are said to have occurred.

On the 8th of November, Lieutenant-Colonel Foster reports from Baton Rouge, Louisiana, that "cholera is upon every boat which passes up and down the river."

It does not seem possible that a clearer demonstration of the agency of individuals in the diffusion of epidemic cholera could be made. It does not seem possible that a clearer demonstration of the cholera truths which have been formulated at the opening of this chapter could be made.

Official records show that the body of troops which embarked on the Henry Clay at the city of Buffalo, N. Y., on the 1st day of July, 1832, were in good physical condition. By Colonel Twiggs, under whose command they embarked, they were spoken of as the finest body of recruits he had ever seen. The Henry Clay had been employed in the transportation of cholera-infected emigrants from the St. Lawrence river. On the fourth day after embarkation, cholera broke out among these troops, and when the Henry Clay reached the Detroit river they were suffering frightfully from epidemic cholera. At Detroit they were joined by two other commands, one consisting of eight companies who had not been exposed to the infection, and an isolated company in Detroit that had been brought to that city on a steamboat which had been exposed to cholera in the persons of emigrants, as was the Henry Clay. The virulence of the epidemic on the Henry Clay started the epidemic flame in the other commands, and in but a day or two the numerical strength of the commands had gone. One steamboat with six companies on board passed through the Saint Clair and ascended Lake Huron, but at Mackinaw she landed four fatal cases of cholera, and passing on in descending Lake Michigan the disease on her decks raged so violently that she arrived a pest-ship at Chicago—an absolutely healthy point prior to her arrival. At Chicago the disease raged until all material was well-nigh exhausted. So far as it was able, it spread in the then sparsely settled country, but presently the embers alone were left. By a gross disobedience of orders fresh victims were infected. By them the disease was carried over one hundred and fifty miles of almost wilderness to the Mississippi river, when the troops under General Atkinson, returning from a victorious campaign, were infected and an epidemic started which cost thousands of lives.

Cholera visited the United States in the years 1833, 1834 and 1835, but no evidence can be found that the troops had any agency in its spread during either of those years. It is a notorious fact that steamboats on the Mississippi, Ohio and Missouri rivers were cholera-infected, and that their agency in the diffusion of cholera in those years was as great as it has been in succeeding epidemics.

I find from the reports of Surgeon R. C. Wood, U. S. Army, that at Fort Crawford, on Prairie du Chien, cholera occurred in August, 1833; that there were twenty-three (23) decided cases with six (6) deaths, while very few escaped the choleraic diarrhœa, and that at the same time in the town of Prairie du Chien twelve or fifteen deaths occurred.

The garrison of Fort Leavenworth, Kan., Jefferson Barracks, Mo., and Jackson Barracks, La., were infected in 1833; and the disease appeared at Fortress Monroe, Va., and Jefferson Barracks in 1834, while in that year the timely removal of the garrison of Jackson Barracks "saved them from total destruction."

The epidemic of 1832 was not confined to troops and citizens; the Indians, who were released by General Scott after cholera attacked the troops at Rock Island, were attacked with the disease before and after they reached their homes, and that it continued epidemic among them is evident from the fact that the bodies of troops who were employed on summer scouts in the Indian country along and between the Mississippi and Missouri rivers, almost invariably suffered from the disease during the years of 1833 and 1834.

CHAPTER XIII.

THE EPIDEMICS OF 1848, 1849, 1850 TO 1857.

THE arrival of the ship Swanton with a cholera cargo, at New Orleans on the 11th day of December, 1848 was followed by an epidemic outbreak which was soon carried to the U. S. troops serving in Texas. Late in December a schooner arrived at Fort Polk, at the mouth of the Rio Grande, from New Orleans, having on board forty (40) Mexican soldiers and their families. These men had served as allies to the U. S. troops between Vera Cruz and the city of Mexico in the then late war. The vessel having arrived during a "norther" was detained off the Brazos bar, and while at anchor a number of cases of cholera occurred on board, one of which died. After crossing the bar three cases were admitted to the post hospital, one being fatal. After some delay the remainder of this company proceeded to Brownsville, Texas, January 24, 1849, where their baggage was opened preparatory to their dispersing to their homes. On the 20th of February a malignant epidemic of cholera broke out in the town of Brownsville, Texas, and in Matamoros, Mexico, on the opposite bank of the Rio Grande.

The disease appeared almost simultaneously in the garrison of Fort Brown.

In Brownsville the epidemic influence extended over a period of thirty days, and in that time one hundred and twenty (120) deaths occurred, one sixth of the inhabitants. At Fort Brown twenty-one (21) cases, with twelve (12) deaths occurred and at Matamoros out of a population of five thousand (5,000) one thousand (1,000) died. February 10th one fatal case occurred at Fort Polk. February 27th the epidemic was malignant on Brazos Island, off the mouth of the Rio Grande. March 5th, the disease again developed at Fort Polk and of eleven (11) cases six (6) were fatal.

From Brownsville and Matamoros the disease spread through the Rio Grande valley, and Camargo lost one-third of its inhabitants, the town of Roma and many villages were depopulated. Doctor Jarvis notes that the cholera transmission along that river may be easily accounted for by the number of emigrants passing up on their way to California, and who suffered severely at different points from the same pestilence.

At Ringgold Barracks on the Rio Grande above Brownsville, the disease appeared March 2d in the person of a soldier, and during the month twenty-three (23) cases with fourteen (14) deaths occurred. The importation of cholera to this post, is very clearly shown in the report of Assistant Surgeon N. S. Campbell. "On the 27th of February, 1849, the U. S. steamer Corvette arrived at the post from Brownsville, at which latter place the cholera was raging. On her passage up the river, one passenger a Californian emigrant, died of cholera; another passenger was attacked but recovered; and the mate of the boat was attacked by the same disease, and died soon after his arrival. Despite all remonstrances, the boat was permitted to come to the usual landing place for U. S. boats, near the center of the garrison; and on the 28th, immediately after muster, the whole command was ordered to unload the boat. They did so, and the steamer left on the morning of March 2d. At 10 o'clock, A. M., on that day the first case occurred, and in one of the men employed in unloading the Corvette."

On March 11th 1849, a squadron of the second U. S. dragoons left Ringgold Barracks, and after a march of five (5) days arrived at Laredo, Texas, a distance of 125 miles. After leaving Ringgold Barracks cholera broke out in the command, fourteen (14) cases with ten (10) deaths occurred, with thirty (30) cases of acute diarrhœa.[1] Laredo was at this time occupied by a command of the 1st U. S. Infantry, who were encamped on the military plaza in the center of the town. On reaching Laredo, the dragoons were encamped on the river bank outside the town, and after making this camp but one case of the disease occurred among them. The camp of the 1st Infantry in the town, however, became infected. "The old military plaza that was surrounded with the refuse of a hundred years became a perfect hot-bed for propagating the cholera germ, and for several days in succession the new guard buried the old guard in the clothes they had on. Many died in less than an hour after they were attacked."[2]

A second importation of cholera into the State of Texas is to be found in the movements of the 8th U. S. Infantry. This regiment had served in Mexico during the war, and in October, 1848, had reached the city of St. Louis, Mo., en route for New Mexico; when from orders there received they again descended the Mississippi river and arrived in New Orleans on the 1st of December, 1848. At New Orleans the regiment was quartered at Jackson Barracks, where it remained until December 12th, when it embarked upon the steamers Telegraph and New Orleans en route for Texas. December 15th, they arrived at Port Lavacca, Texas, but they were not landed until the 19th, when a camp was established about two miles from the town. On the 21st, one battalion was marched twelve miles into the country. The same night cholera had attacked both camps, and by the morning of the 22d more than one-eighth of both commands had the disease.[3] The disease continued with great violence until the 30th. In one hundred and ninety-six (196) cases there were one hundred and thirty-three (133) deaths, and many women and children belonging to the regiment died of the disease. This command did not reach San Antonio, Texas, until some time in the month of February, 1849, and no record of any cases of cholera having occurred among it can be found for some time before and after they reached the city.

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[1] Report of Asst. Surgeon Glover Perin, U. S. A.

[2] Statement of Gen. E. L. Viele. Journal Mil. Ser. Inst., March, 1885.

[3] In a recent paper on "Camp and Garrison Sanitation," published in the Journal of the Military Service Institution, March, 1885, Gen. E. L. Viele has followed an error which occurred in my History of Cholera in America, namely, that the 8th U. S. Infanty carried cholera into the State of Texas in 1848, and were responsible for its epidemic diffusion. I cannot find that the cholera infection of this regiment spread to other troops. When that command reached San Antonio it was, according to reports, free from the disease. It is more probable that General Worth became infected with cholera on his journey from New Orleans to San Antonio. Report of Surgeon Madison Mills, U. S. A.

The movements of emigrants, large numbers of whom arrived at New Orleans in December, 1848, and the early months of 1849, had undoubtedly been the most active cause of the diffusion of cholera. During those months every steamboat upon the Gulf coast was a floating pest-house. Emigrants flocked unchecked over every line of travel, and it is most probable that cholera was epidemic in the city of San Antonio early in the month of April, although the troops were not affected until May 1st, when cholera broke out in the camp of six companies of the 3d U. S. Infantry at Saledo near San Antonio. The third day after the first case occurred, and when it was convalescent, the stream on which the camp was situated suddenly rose about twenty feet and flooded the camp. Most of the command were obliged to swim in escaping from camp to a higher ground of the prairie. All were wet and lay all night on the prairie, without tents or other covering, during the heavy rain. The next day was one of great fatigue for the men. On the second day three cases of cholera occurred."[1] Seventy-five (75) cases occurred, of which twenty-eight (28) died. The last case occurred May 15. On the 7th of May, Major-General Worth died of cholera at San Antonio; he had but recently returned from New Orleans.[2] No other record of cholera having affected other bodies of troops in Texas can be found, but in Fenner's Medical Report for 1849, Surgeon Jarvis, U.S.A., shows how cholera was diffused through Texas by emigrants and into Mexico by refugees from Texas.

The epidemic of 1848 was continued into the following year in other localities. In the months of July and August, 1849, nineteen (19) cases with fifteen (15) deaths occurred on Governor's Island, New York harbor. At Carlisle Barracks, Penn., a recruit received from Governor's Island died of cholera in July, and eleven (11) cases with three (3) deaths occurred in quick succession. At the Military Academy at West Point, N. Y., on July 17th, "a fatal case of dysentery," showing in a very marked degree toward its close some of the symptoms of cholera, had occurred, and on August 11th an unmistakable cholera death occurred. In all there were five (5) cases and three (3) deaths. At this time cholera was common along the line of the Hudson River Railroad, and at the small town of Canterbury (12 miles distant) twenty deaths had occurred.[3]

At Newport Barracks, Ky., eighty-five (85) cases with five (5) deaths were reported. On July 1st cholera was reported at the Detroit Barracks; it is reported that but one soldier died of the disease and only about one hundred in the city of Detroit "including those landed from the steamboats."[4]

It cannot be shown that either of the posts named were centers of infection and of diffusion, save in the instance alone of Governor's Island; but from the Mississippi river westward, the trail of epidemic diffusion is very plain. The years of 1848 and 1849 and those immediately succeeding were the years of "rush" for California. Many were emigrants, but the majority were of the restless population of the United States. Numbers of these California emigrants were carried by Atlantic steamers to the Isthmus and by Pacific steamers to San Francisco—but thousands traveled overland, many by the southern routes through Texas—and thousands from the Missouri river. The starting points of this latter class were Independence and St. Joseph, Mo.; Leavenworth, Kansas, Omaha, Nebraska, and other Missouri river towns.

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[1] Report of Asst. Surgeon L. H. Stone, U. S. A.
[2] Report of Surgeon J. J. B. Wright, U. S. A.
[3] Report of Surgeon J. M. Cuyler, U. S. A.
[4] Report of Surgeon Chas. S. Tripler, U. S. A.

In the early months of 1849 cholera was almost universally diffused over the Mississippi valley, and almost all the river steamboats were infected. Early in April the disease was epidemic in St. Louis and in the preceding month the steamboats on the Missouri river were reinfected. April 21, the steamboat Sacramento landed a large number of cholera-infected emigrants at St. Joseph, Mo. She was rapidly followed by other boats, also infected. On the steamboat Mary over fifty (50) cholera deaths had occurred after she left St. Louis. What is stated of cholera arrivals at St. Joseph is also true as to Independence, Leavenworth, Omaha, and other river towns. At these points outfits were obtained, messes were formed, and for mutual protection large companies marched from these rendezvous, carrying the cholera poison with them. As the years from 1848 to 1855 were years of gold excitement and the flood of California travel, so were they years of almost uninterrupted cholera diffusion over that vast territory which lies west of the Mississippi river. One broad trail of emigrant travel extended westward through Kansas along the line of the Smoky Hill fork of the Kansas river. Another was through Nebraska along the line of the Platte river. From Independence, Mo., Leavenworth, Kan., St. Joseph Mo., and Omaha, Neb., these lines of travel converged and crossed each other at various points before the broad trail was taken up on the Kansas or Nebraska routes, and for many miles west of these principal rendezvous the country was marked with old and new camps. The favorite camping-grounds were always in the vicinity of small towns and villages; for even in the excitement for the El Dorado, emigrants were loath to turn their backs upon the abodes of man so long as they could be reached without deviation from their line of march. During these years a large emigration of Mormons was taking place, and thousands were upon the march for Utah. The "outfit" of a party of emigrants consisted of a light wagon, in which women and children, clothing, bedding, food and such articles of camp furniture as they possessed were carried, while the men marched. Many, however, did not possess the means to obtain this luxury and all contrivances were made use of—pack animals, push carts, wheelbarrows—while the most unfortunate trusted to their own broad shoulders to bear the burden.

In June, 1849, a recruit from St. Louis died of cholera at Jefferson Barracks; this was followed by eighty-one (81) cases of the disease with eleven (11) deaths. The epidemic lasted until March 27th. In the following May a few cases occurred. In the same month and about the same date, cholera became epidemic at Fort Leavenworth, and lasted until the close of the following August. At this post the medical officer reported that the epidemic was preceded by a diarrhœa which seemed to affect the entire command, as it did the inhabitants of the surrounding country.[1] At Fort Kearny, Nebraska, one case of cholera occurred in the person of a soldier from Fort Leavenworth. No case occurred in the command or at the post, although emigrants passing were suffering from the disease.[2]

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[1] Report of Surgeon Chas. McDougall, U. S. A.

[2] Report of Asst. Surgeon Wm. Hammond, U. S. A.

At Fort Laramie, Wyoming, the only instances of the disease were in three (3) soldiers who had formed an escort party from Fort Kearny, one of whom had cholera late in July, another on August 1st, immediately on their arrival. They were the only cases at the post, although cholera continued epidemic among emigrants to a point fifty (50) miles east of the post.

The only other military posts from which reports of cholera in 1849 can be found are at Fort Smith, Arkansas, where in Jnne, Asst. Surgeon J. H. Baily reports the prevalence of cholera on Arkansas river boats arriving at the post, and adds that there has been but "little proclivity to the disease, either among the troops or the inhabitants of the place." At Fort Gibson, one hundred and twenty (120) miles further up the Arkansas river, Surgeon J. B. Wells reports cholera upon the river boats, and that on the 15th of July the disease developed in the 5th U. S. Infantry, with a large number of cases and many deaths.

In 1850 cholera was still epidemic along the Mississippi and its tributaries, and river steamers were again the porters of the infection. At Jefferson Barracks the epidemic opened in June and continued to August.

In June a non-fatal case occurred among the garrison of the St. Louis Arsenal, and the Medical Officer[2] reported that "since the commencement of May very unmanageable cases of cholera have been observed in St. Louis, and at the Arsenal a good deal of diarrhœa prevailed among the men."

At Fort Kearny, although on the line of emigrant travel (among the emigrants the disease raged) no cases are reported. In the spring of 1850, a large detachment of recruits left Fort Leavenworth for Fort Laramie. This command was perfectly healthy when the march began and continued in good condition until the line of march met the emigrant road for Independence on one side, and St. Joseph on the other; then they were on the line of emigration, and when they arrived at the Big Blue fork, cholera broke out among the men.[3] I am unable to find any record of this long march from the crossing of the Big Blue to Fort Laramie, where the garrison remained healthy until after the arrival of this body of recruits, although in this year the emigrant cholera trail extended to the upper crossing of the Platte river, a distance of 470 miles from the crossing of the Big Blue. On June 21st, cholera was epidemic, and lasted until July 20th. Thirty (30) cases in all occurred, but nine (9) of whom were old soldiers. Doctor Moore remarks that in this year cholera was confined to the road and among emigrants—but many Indians remained on the road from curiosity and for the purpose of begging; they paid a terrible penalty. Other bodies of Indians, wiser than these, left the road so soon as they learned there was disease among the whites and escaped. During this year many sick emigrants were left at this post, yet the disease did not spread.

In 1851 cholera was still epidemic on the Mississippi river, and the record shows that Jefferson Barracks, in June of that year, again became a center of infection. It is not improbable that the epidemic of this year was caused by the arrival early in June of a detachment of ninety (90) recruits for the regiment of mounted rifles, who had been transported

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[1] Report of Surgeon S. P. Moore, U. S. A.

[2] Asst. Surgeon Aberdie, U. S. A.

[3] Report of Surgeon S. P. Moore, U. S. A.

from Carlisle Barracks on a canal-boat to Pittsburgh, Penn., and thence by Ohio River steamboat to Jefferson Barracks. Cholera broke out while on the Mississippi river; none had died before they arrived at Jefferson Barracks, but quite a number were so ill on arrival that they were carried to hospital. In the first six days after arrival fifteen (15) had died.[1]

At Fort Leavenworth cholera was epidemic in the months of May, June and July. The reports show that the cholera was brought from St. Louis with troops. At Fort Kearny on the 28th of June a case of cholera occurred in a recruit who had just arrived from Fort Leavenworth. No other cases are reported.

At Fort Smith, Arkansas, on the 31st of May, two companies of the 5th U. S. Infantry arrived from Corpus Christi, Texas, with cholera which had broken out two days before their arrival. The companies had been transported on a Mississippi river boat. The disease infected the garrison and an aggravated epidemic occurred, which spread to the town and lasted until the following July. Of fifteen hospital attendants, seven (7) had cholera, two (2) died and four barely escaped with their lives.[2]

In September an epidemic outbreak occurred at Newport Barracks, Ky. The disease had previously appeared in the city of Newport, and the epidemic was remarkable from the fact that but nine (9) deaths were reported in eighty-five (85) cases.

In 1852, a few cases of cholera occurred on Governor's Island, in August, and at Jefferson Barracks in April, May, and at Fort Leavenworth in the month of May. A few cases occurred also at Newport Barracks among recruits who had been brought by steamboat from St. Louis, Mo.

In June two (2) cases occurred at Fort Kearny. The men had both been on detached service at the village of Pawnee Indians on the Platte river, about thirty miles from the State line. No other cases are reported at post—cholera still reported as being among California emigrants. In this year the medical officer at Fort Laramie reports that cholera is very virulent among emigrants, over one thousand of whom have died along the Platte route; that the disease has affected all classes of emigrants, but that although the post is surrounded by them, the hospital crowded with their sick, and that almost all who were taken sick died, yet no case occurred among the troops although free communcation with the emigrants was permitted.[3]

In this year a most interesting outbreak of cholera was reported by the late Surgeon Charles S. Tripler, U. S. A., and I regret that I have not space to reproduce the entire report, so characteristic is it of all work done by that distinguished officer. Eight companies of the 4th U. S. Infantry left New York harbor, July 5th, on the steamship Ohio, for Aspinwall. The command, including women and children, numbered eight hundred. During the voyage a number of cases of diarrhœa occurred, but when the steamer reached Aspinwall, July 19th, no death had occurred. Cholera was epidemic at Aspinwall when the command was disembarked, and it was epidemic at both Cruces and Gorgona on the route across the Isthmus. It was also epidemic among the laborers on the railroad. The command, for want of transportation, was delayed at Aspinwall one day; the next it was transported on two trains to the terminus of the railroad at Baracoa. At that point it was determined to divide the command into two detachments, the main body to be transported by boat on the Chagres river to Gorgona, from which town it was to march to Panama. The second detachment consisting of the sick, the women and children, one company and all regimental baggage was to be carried by boats to the town of Cruces, where they would be provided with mule transportation to Panama. Doctor Tripler was ordered to accompany the last detachment. July 18th the first detachment was under way for Panama; that day the second detachment was detained at Baracoa on account of the non-arrival of the baggage, but the next day it proceeded to Cruces, where a failure on the part of the contractor to furnish transportation detained the detachment for three days. At Cruces cholera was epidemic, and although every exertion was made to save the detachment from the infection, the cupidity of the contractor condemned them to three days of inaction, and on July 20th[1] the disease broke out in the command. The first case died after an illness of six hours. The next day (July 21st) the detachment was sent forward, but notwithstanding every precaution three fatal cases occurred before it reached Panama. On reaching Panama, Dr. Tripler learned that the main body of the troops had been three nights on the road between Gorgona and Panama without shelter; that they had been drenched by the rain every day; that the orders in regard to food and drink had been disregarded; that several men had been attacked with cholera and had died on the way; that on reaching Panama the troops had been embarked on the steamer Golden Gate, then lying at anchor off Tobago, twelve miles down the bay; but that after embarkation fresh cholera cases had occurred, and that the sick had been placed on a "hulk" anchored near by, on which a cholera hospital had been improvised.

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[1] Statement of Gen. E. A. Carr, U. S. A.

[2] Report of Acting Asst. Surgeon N. Spring, U. S. A.

[3] Report of Asst. Surgeon G. K. Wood.

A delay of twenty-four hours was experienced at Panama, before the men of the second detachment could join the main body on the Golden Gate. The hospital on the "hulk" was continued, and to it all suspicious cases were transferred as they occurred.

On Tuesday, July 27th, the disease seemed to be abating, but on the evening of that day about a dozen knapsacks (which had been left on the Isthmus) were received on board the steamer, and were immediately opened by their owners. In about 20 hours all of these men were taken with cholera in its worst form, and most of them died. On July 29th the command was removed from the steamer and placed on the Island of Flamingo, about six miles below Panama. The last case on the steamer occurred August 1st. On this island a number of those previously ill died, but no new cases occurred; but to add to their misfortune, the Chagres fever appeared.

On the 3d of August the Golden Gate sailed for San Francisco with 450 well men, the officers of the ship refusing to receive any who were sick. Doctor Tripler was therefore left in Flamingo, with all the sick, most of the women and children, and one company of troops. On the 8th of August, this party was received on the steamer Northerner and sailed for San Francisco, leaving four cases in the hospital at Tobago.

On the Golden Gate, in her voyage from Panama to San Francisco, there were ninety cases of fever and diarrhœa, with three deaths among the troops. On the Northerner one man died "of the secondary fever of cholera."

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[1] It is a point of interest that Gen. U. S. Grant, then the regimental quartermaster, was on duty in this detachment, and that it was owing to his exertions that the detention at Cruces was not prolonged.

The only cholera record I can find of the disease among U. S. troops in 1853 is at Fort Columbus, Governor's Island, where in July two cases of the disease are reported, both recovering.

In 1854, cholera was epidemic at Jefferson Barracks from March to November. The number of cases I cannot state, but the mortality is reported as one in three. In June the disease was reported at Fort Leavenworth, but in a modified form. At Fort Columbus, Governor's Island, there were two distinct outbreaks, one in July, when thirty-eight (38) cases with nine (9) deaths occurred; one in September when six (6) cases with two (2) deaths occurred. At Fort Snelling, Minn., one fatal case was reported in the person of a recruit. From Forts Kearny and Laramie reports of the disease still existing along the emigrant roads were received.

Cholera was again reported in 1855 at Fort Leavenworth in April, and the epidemic influence lasted until October. One hundred and fifteen (115) cases with forty-seven (47) deaths are reported. No record is found of the epidemic being at Jefferson Barracks in this year, yet the presumption is strong that the epidemic influence remained from the preceding year, from the fact that in April cholera broke out in a battalion of the 6th U. S. Infantry en route from Jefferson Barracks to Fort Kearny, Nebraska. In this command the disease lasted through the months of April, May and June.

In June and July cholera attacked a detachment of the 2d. U. S. Infantry which was ascending the Missouri river from Fort Leavenworth to Fort Pierre, on the steamer Arabia; fifty-two (52) cases occurred.

In July cholera appeared at Fort Riley, Kansas; this post was at the time garrisoned by a detachment of forty-seven (47) men of the 6th U. S. Infantry; but several hundred quartermasters' employees were engaged in construction of the fort. Of the forty-seven (47) soldiers, twenty-one (21) had cholera and nine (9) deaths occurred; this number of fatal cases includes one officer. The disease was very fatal among the mechanics, who fled from Riley in great dismay and confusion. I am informed by a distinguished officer of the army that, having received promotion in the 1st U. S. Calvary (then organized), he had been through the spring of 1855 recruiting in Georgia, and that in July of that year he arrived with a large detachment of recruits at Jefferson Barracks. These recruits were from rural districts of Georgia and Alabama. They were perfectly well until they reached Nashville, Tenn., where they were placed on a steamboat, when they were taken with diarrhœa. After reaching the Mississippi river, several died of cholera, and several other deaths occurred after arrival at Jefferson Barracks. From April to September, a few cases of cholera were reported at Baton Rouge Barracks, La.

The persistence of cholera in an epidemic form at Jefferson Barracks and Fort Leavenworth in 1849, 1850, 1851, 1852, 1853, 1854 and 1855, if indeed those posts escaped in 1848 and 1856, is to be found in the fact that Jefferson Barracks was during the years named a rendezvous for troops effecting regimental organization or changing station, and that Fort Leavenworth was a general depot for supplies, as well as a rendezvous for troops. Both posts are upon river banks, both liable to receive infection from passing steamers, both were in close proximity to cities.

On Governor's Island, New York harbor, where cholera had been epidemic in 1849, 1852, 1853, 1854, a seemingly isolated outbreak occurred

November, 1857, and was confined to the recruits who were quartered in Old Castle William. The late Surgeon C. H. Laub reported as follows: "The Castle, which is damp and ill-ventilated, has been the point or focus from which on previous occasions the disease has emanated, and when the disease appeared this time the sleeping apartments occupied by recruits were overcrowded; sometimes as a matter of necessity fifty or sixty were occupying the same room."

CHAPTER XIV.

THE EPIDEMIC OF 1866 IN THE UNITED STATES ARMY.

In 1866, the depots from which recruits were distributed to the various regiments were Governor's Island in New York harbor and Carlisle Barracks in Pennsylvania—Governor's Island for the infantry, Carlisle for the cavalry arms of the service. Recruits reached these depots after enlistment had been accomplished at the various rendezvous; the rendezvous were located in all the principal cities of the United States, and in that portion of those cities in which the classes from which recruits for the army are obtained do most congregate. A recruit at either rendezvous or depot is not deprived of his liberty, but when off duty is permitted to leave the confines of military jurisdiction at the pleasure of his commanding officer. During the months of April, May, June, and the early days of July, 1866, there was no actual reason why recruits should be rigidly confined to Governor's Island; the presumption is that they were not so confined, but that they had mixed with their fellows in both New York and Brooklyn. A large proportion of all recruits secured for the army are of foreign birth, and it is probable that among the nearly four thousand (4,000) emigrants who arrived at New York during the months of April and May, 1866, on cholera-infected ships, many were friends of newly enlisted soldiers on Governor's Island.

On the 3d of July, two (2) cases of cholera occurred among the recruits on Governor's Island. On the 8th of July cholera broke out on Hart's Island in recruits who had been sent there from Governor's Island. At this post a severe epidemic occurred, and the garrison was removed to David's Island, where a few new cases occurred among the troops so transferred. One case occurred at Fort Schuyler in the person of an officer who had slept on a steamboat used the day before in transporting the cholera-infected command between Hart's and David's Islands. The other garrisons in New York harbor escaped, nor did any cases occur among enlisted men on detached duty in New York city. The total number of cases reported among these infected troops was one hundred and eighty-one (181) with seventy-five (75) deaths.

The first point at which occurred an explosion of cholera, known to have been contracted at a military post in New York harbor, was Boston, Mass., where, on the 19th of July, a soldier who had been on duty in the cholera hospital died at the Soldiers' Rest.

On the 14th of July the steamship San Salvador left New York for Savannah, Georgia, with seventy (70) cabin passengers, sixty (60) in crew and steerage, and four hundred and seventy-six (476) recruits for the Seventh U. S. Infantry. The troops were between decks and much overcrowded. On the steamer cholera broke out among the enlisted men, and when she arrived at quarantine below the city of Savannah, on the 18th, three (3) cases had died and twenty-five (25) were under treatment. The troops were landed on Tybee Island. A camp and hospital were established and two hundred and two (202) cases of cholera with one hundred and sixteen (116) deaths occurred. "The cabin passengers and crew of the San Salvador appear to have escaped, but of the ten (10) white citizens residing on Tybee Island nine (9) were seized with cholera shortly after the arrival of the San Salvador and five (5) died. The tenth fled from the island and is reported to have died of cholera in the interior."

No cases of cholera occurred among the troops stationed in Savannah, and none are reported as occurring among citizens.

Detachments of recruits from New York harbor were received at Jackson Barracks, New Orleans, La., on July 8th from the steamship Mariposa, on July 16th by steamship Livingston, and on July 23d from Carlisle Barracks via New York harbor on steamship Merrimac. At quarantine station below New Orleans, two or three sick soldiers had been taken from the Livingston; one case died. As to the steamship Mariposa no record can be found, but on the 12th of July, four days after the reported arrival of the Mariposa, cases of cholera occurred among citizens of New Orleans. The steamer Livingston left New York harbor on July 8th, having on board a detachment of five hundred and nineteen recruits (519) from Hart's Islandall in good health. On the first day out a case of diarrhœa occurred which terminated fatally the next day. On the seventh day out a second recruit was taken with cholera and died in a few hours. On July 15th, the Livingston reached the Mississippi river quarantine, and put off two recruits sick with diarrhœa, one of whom died. On the 16th of July the command was disembarked at Jackson Barracks, two cases of cholera were sent to hospital, one of whom died with choleraic symptoms. On the 29th of July the steamer Merrimac arrived and landed some two hundred (200) recruits at Jackson Barracks.

On the 25th of July a case of cholera occurred at Jackson Barracks in the person of one of the recruits received from the Livingston. From this date the disease spread rapidly among the troops at Jackson Barracks, and in the city of New Orleans; it is reported that from July to October 31st, one thousand one hundred and eighty (1,180) deaths occurred among citizens, and one hundred and seventy-three (173) deaths among the U. S. troops.

Cholera was carried to Forts Jackson and St. Philip below New Orleans, on the river, by troops returning to their posts after the riots of July 30th. The first case occurred August 10th, and was followed by sixteen (16) cases and eleven (11) deaths.

August 3d, cholera developed at Greenville, La., among troops returning from duty in New Orleans during the riot. August 17th, cholera was reported among the troops at Baton Rouge, La., and during the next two months there were sixty-nine (69) cases and forty-three (43) deaths. At Ship Island, Miss., there was a fatal case of cholera on Sept. 8th, which was followed by other cases, among military convicts.

September 22d the disease appeared at Shreveport, La., where eleven (11) cases with four (4) deaths occurred in the command. From the city of New Orleans cholera was carried by troops into the State of Texas. On the 19th of July the detachment of recruits which had arrived at New Orleans on the steamer Livingston from New York harbor were embarked on the steamer Texas for the city of Galveston, where they arrived July 22d. The day after arrival at Galveston a recruit was taken with cholera and died in thirty-six hours, and in the ten days following thirteen (13) cases occurred among these recruits, of whom six (6) died, with an average duration of the disease of about eighteen hours.[1] The disease existed among the troops at Galveston during the succeeding month (August) with a total of forty-four (44) cases and twenty-four (24) deaths.

The headquarters of the department of Texas being at Galveston, the main body of troops and recruits who arrived at that city, did not remain for any considerable length of time, but were speedily forwarded to different regiments and posts. At the distance from records at which I write I am unable to give full information of such movements.

The history of the two hundred (200) cavalry recruits who had arrived at New Orleans July 24th, on the steamer Merrimac, must now be followed out. On being disembarked, these recruits were encamped near Jackson Barracks for a few days. On the fourth or fifth day after landing a case of cholera, which proved fatal, occurred among them, when the detachment was promptly forwarded to Texas. They were placed on one of the Morgan Gulf line steamers, and were transported to Indianola, Texas, making a stop at Galveston. The date of the departure of this detachment from New Orleans was probably August 5th, they arrived off Galveston probably on August 8th, and the disembarkation at Indianola was probably August 9th or 10th. I am informed by an officer who accompanied this detachment from Carlisle Barracks, Penn., to San Antonio, Texas, that after arrival at Indianola the recruits were transferred to the deck of a schooner and carried to Lavaca, from whence they were transported by rail to Victoria, and that they were marched from the latter point to San Antonio, a distance of fifty miles, arriving at San Antonio probably between August 19th and 20th, and although no cases of cholera are known to have occurred among them after leaving New Orleans, diarrhœas were prevalent.

From Galveston cholera was carried by the movement of recruits to White's Ranch on the Rio Grande, where it occurred August 13th; to Brownsville, August 20th; to Brazos Santiago, August 21st; at these three (3) posts three hundred and eleven (311) cases with one hundred and forty-nine (149) deaths occurred. By Mexican freight trains cholera was carried from the Rio Grande to San Antonio, where the first case occurred at the San Juan Mission, six miles from the city, on the 2d day of September in a person who had just arrived in one of these trains from the Rio Grande.

From the Mission the disease was carried into the city of San Antonio in the person of a Mrs. DeWitt, who had been taken ill at the first stated point. Other cases among citizens rapidly followed, and an epidemic was established. At this time the 4th U. S. Cavalry and a detachment of the 17th U. S. Infantry were stationed at San Antonio. These troops, so soon as the epidemic presence was known, were ordered to camp upon the Medina, a distance of twelve miles from the city. Asst. Surgeon P. V. Schenck reports, relating to the 4th U. S. Cavalry: "*The time for moving proved, peculiarly unfortunate, for when one-half of the command had moved, a flood of before unheard-of severity came, causing the river to overflow the camp and converting that which had been dry into a huge mudhole.*" In this condition of affairs cholera broke out in the camp (September 7th) in the person of one of the two hundred recruits just before received, and spread with great rapidity. At or near the same date cholera attacked that portion of the cavalry regiment that was in San Antonio. So soon as the roads became dry enough to move, these companies were moved to camp, a cholera hospital established, and every effort was made to stamp out the disease. The greatest mortality was reached on the 19th and 20th of September when the disease rapidly diminished, and on the close of the month had entirely disappeared.

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[1] Report of Surgeon E. P. Vollum, U. S. A.

On the 15th of September the detachment of the 17th U. S. Infantry left San Antonio for camp on the Medina; up to that date no cholera had been among them, although they had been surrounded by the epidemic. This camp was made at some distance from the cavalry camp; strict non-intercourse was maintained, and every sanitary precaution adopted; Asst. Surgeon W. M. Austin, U. S. Army, reports: "Notwithstanding, cholera did appear; though it did not spread, nor last long. I trace its origin to the fact that two Mexican teamsters coming from the town stopped one night near the camp and died from cholera. I immediately had them and their effects buried, kindled a large fire on spot where they died, and disinfected it; a sentry kept the men away; two days after, cholera appeared in camp." In these two commands three hundred and eighty-seven (387) cases occurred with sixty-four (64) deaths.

The epidemic was violent in San Antonio. Dr. Austin states that those unprejudiced estimated the deaths at about five hundred, and that though the real number of deaths was studiously concealed, it was known that forty-five permits for burial were issued in one day. Dr. Schenck estimates the deaths at nearly six hundred in a population greatly diminished by those that fled. He gives an interesting account of a Roman Catholic College in the center of the city which was filled with students, who closed their doors and allowed no one to enter or depart, and who escaped the disease entirely.

At Indianola, cholera became epidemic about September 5th. I am not able to record all the arrivals of recruits and of troops at this point during the year; but a point of interest has come to my knowledge in relation to the two hundred cavalry recruits from New Orleans. I am informed by the officer before referred to, who accompanied this detachment, that when they were landed from the New Orleans steamer no supply of drinking water had been obtained for the command, and that they, suffering extremely from thirst, had been allowed to leave camp and obtain water for themselves. These recruits probably visited all portions of the town.

In September a detachment of one hundred recruits for the 5th U. S. Cavalry, then stationed at Austin, Texas, arrived at Indianola, where they were attacked with cholera. They were marched out of town at once, but before reaching Austin, ten (10) deaths occurred. When a few miles from the city they were quarantined, but this quarantine was reported by Assistant Surgeon Bacon, U. S. A., as "imperfect." Seven (7) deaths, occurred and soon after the arrival of this detachment two (2) fatal cases occurred among the troops in the city; but the disease died with them and no new cases occurred until the following November, when ten (10) cases occurred, all of which were fatal.

The movements of other bodies of recruits from New York harbor requires some consideration. It has been stated that during this epidemic one hundred and eighty-one (181) cholera cases with seventy-eight (78) deaths had occurred on Governor's, Hart's and David's Islands, New York harbor. These cholera cases were, however, accompanied, at the three (3) posts at which they occurred, by forty-nine (49) cases of cholera morbus, among whom no deaths occurred, and one thousand one hundred and fifty-six (1,156) cases of acute diarrhœa among whom one (1) death was reported; and it is not unreasonable to suppose that through the dejecta of persons suffering from acute diarrhœa the area of epidemic influence was extended.

A detachment of one hundred and forty-five (145) recruits arrived at Vicksburg, Miss., from Governor's Island on the 11th of July. August 21st a barber employed among the troops died of cholera; the next day (22d) two fatal cases occurred in the command and fifty-nine (59) cases of cholera with twenty-five (25) deaths followed. July 17th a detachment of fifty-one (51) recruits from Governor's Island arrived at Jackson, Miss. In this command during August and September there were eight (8) cholera cases and six (6) deaths. During the five months ending with December, 213 cases of acute diarrhœa, occurred with two deaths.

From the 16th to 19th days of July, detachments of recruits from Governor's Island amounting to three hundred and sixty-four (364) men arrived at the U. S. Barracks in the city of Louisville, Ky. On arrival diarrhœas prevailed among them. A fatal case of cholera in the person of a recruit occurred July 29th, followed by two fatal cases on the 31st, thirty-six (36) cases with twenty-three (23) deaths in all. It was reported that more than 50 per cent. of the cases were from one company which was chiefly composed of recruits. Reports at the time divided the command for purposes of observation into three classes, viz: I. Old soldiers; II. Recruits who had enlisted at Louisville; III. Recruits received from New York Harbor. And it was determined that the New York recruits had suffered most severely, the post recruits less, and that the old soldiers had suffered but slightly. During July, August and September two hundred and twenty-one (221) cases of acute diarrhœa occurred in this command.

On the 31st of August the company, in which it is reported that more than 50 per cent. of the Taylor Barracks cases of cholera had occurred, was ordered to Bowling Green, Ky. On departure, this company left six (6) cholera cases in the post hospital. After arrival at Bowling Green and within the first three days, six (6) cases occurred, followed by two (2) other cases in month of November; all recovered. In this command there were sixteen cases of acute diarrhœa.

A most interesting local epidemic is to be found in the history of the 56th U. S. Colored Infantry, which regiment, until the 7th of August, had been stationed at Helena and Duvall's Bluff, Arkansas. Being ordered to St. Louis, Missouri, they moved in two detachments from Helena. Five (5) companies that had been stationed at Duvall's Bluff, on White river, were embarked August 9th on the Mississippi river steamer Continental. The regimental headquarters and remaining five (5) companies following on August 10th on the steamer Platte Valley. A special inspection of the post of Duvall's Bluff made by the Medical Director of the Department of Arkansas on the 1st of September failed to discover the presence of cholera there, although it had been reported that fatal cases had occurred on steamboats plying the White river. The disease did not appear at Helena until August 30th, therefore this regiment at the date of embarkation on the steamers Continental and Platte Valley were most probably free from cholera infection. The regimental commander reported that both boats were large and had the usual accommodations, and that the command had been unusually healthy during the summer. Cholera broke out on the Continental shortly after leaving Helena; one case was put ashore at Memphis, Tenn. (case of August 15), and when she reached Cairo, Ill., she had on board thirteen (13) cholera dead and about sixty cases (60) under treatment. The steamer proceeded to quarantine grounds below Jefferson Barracks, Mo., where the troops were disembarked and a cholera hospital established. About twenty-four hours after leaving Helena a death occurred on the Platte Valley, which, there being no medical officer on board, was supposed to be from a congestive chill; and a similar case occurred on the boat between Cairo and St. Louis. During this time some fifty odd men of this command were taken sick from various diseases. At Cairo a physician had been engaged to accompany the boat to St. Louis. On arriving at quarantine grounds, a careful inspection of the troops, passengers and crew of the Platte Valley was made, but no cholera was found. She then proceeded to the city of St. Louis, where she arrived at midnight of the 13th. The command was kept on board. Early the next morning the medical officer reported a case of cholera. The Platte Valley was ordered at once to quarantine grounds, the troops disembarked and a camp formed, which was kept distinct from the camp of the troops who arrived on the Continental. At this camp cholera raged during the remainder of August and through September. In the command numbering six hundred and twenty-three (623) men, two hundred and fifty-six (256) cases and one hundred and thirty-nine (139) deaths occurred, and this number of deaths does not include those who died on the river before reaching quarantine grounds below Jefferson Barracks. While the epidemic lasted two hundred and thirty-four (234) cases of acute diarrhœa were treated in the camp. A more marked instance of the agency of common carriers in the diffusion of disease can scarcely be found. Both the Continental and the Platte Valley were steamers in the New Orleans trade, both were bound up the river from below Helena, where this most unfortunate command was embarked upon them. When marched aboard these steamers, the troops were absolutely free from cholera; when they were disembarked, cholera had infected the whole regiment.

To a limited extent cholera spread among the garrison of Jefferson Barracks in the months of August and September. In August, with a command of two hundred and eighty-four (284) mean strength there occurred six (6) cases of cholera and five (5) deaths. In September the mean strength of the command was three hundred and forty-four (344); there were two (2) cases both of which were fatal. During both months the number of cases of acute diarrhœa was very large, being one hundred and three (103) in each month, with no deaths.

It is not positively known how cholera reached the city of St. Louis in 1866, and at this late date it seems impracticable to arrive at a solution of the problem. The diffusion could not have been by the steamer Platte Valley, for she arrived August 13th, whereas the disease was in the city as early as July 27th, according to one authority and not later than August 3d by the most recent (Mr. Robert Moore of St. Louis).

Four (4) cholera cases with three (3) deaths occurred during the months of August and September in the Ordnance detachment at the St. Louis arsenal, the first fatal case occurring August 17th.

In the history of the cholera epidemic of 1873 in the United States, on

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[1] That Jefferson Barracks escaped a severe visitation of cholera in 1866 was mainly due to the thorough sanitary management of Col. E. Swift, Surgeon U. S. A., then post surgeon.

page 672, I made the statement that "during the epidemic St. Louis lost eight thousand five hundred (8,500) cases." A recent investigation of the records of this epidemic as it affected St. Louis, by Mr. John Moore (in which he was able to use records inaccessible to me when my investigation was made, ten years ago), shows that the total number of fatal cases in that city was "three thousand five hundred and twenty-seven (3,527)." This statement is based upon two independent examinations—one made by the board of health during the occurrence of the epidemic, the other by a house-to-house inquiry by the city assessors after the subsidence of the epidemic.

After a careful consideration of all the circumstances, I am more than willing to accept the accuracy of the enumeration of Mr. Moore. The few facts which I was able to furnish were laboriously obtained. My enumeration was taken from newspaper reports, where all totals were expressed in numerals, and it is very easy to understand how 3,500 could be so printed as to represent to the eye 8,500.

During the months of August and September, a serious outbreak of cholera occurred among the troops stationed at Richmond, Virginia. In a command of about fifteen hundred (1,500) men, two hundred and seventy-one (271) cases with one hundred and three (103) deaths occurred. The first case was on August 12th, in the person of a soldier who had spent the previous night in a debauch in the city. On the 13th, four men from the same company as the first case were attacked. These five men had been in together on the debauch of the night of August 11th. During the two succeeding days ten new cases were admitted to hospital, eight of whom were from the same company. While cholera was epidemic five hundred and ninety-two (592) cases of acute diarrhœa were treated.

During the months of July and August recruits had been received from Newport Barracks, Ky., and from New York harbor. The disease was carried by companies of troops from Richmond to Fortress Monroe, Norfolk and Yorktown, Va., but did not spread.

The only eastern point left unnoticed which had been designated as a focus for cholera in the army, is Carlisle Barracks in Pennsylvania. It is certainly unjust to apply such a designation to Carlisle. It was the depot for cavalry recruits, and during 1866 cavalry recruits were certainly agents in the diffusion of cholera; but they certainly did not convey that infection from the depot, but it was communicated to them after they had been sent forward to their regiments. It has already been shown how a body of two hundred cavalry recruits were sent to New York harbor for transportation to Texas while cholera was existing on Governor's, Hart's and David's Islands. It has been shown that these recruits reached Jackson Barracks, Louisiana, after cholera had been epidemic in New Orleans, that one fatal case had occurred among them while at Jackson Barracks, but that no other cases can be found among their numbers until they were in San Antonio, Texas, and the cavalry camp on the Medina twelve miles from that city. It is true that the first cases in the 4th U. S. Cavalry were among their number, but cholera had been epidemic in San Antonio for some days before they were attacked.

Surely nothing animate or inanimate at the cavalry depot had any agency in that diffusion. The cholera history of Carlisle Barracks in 1866, is simply this: On the 12th of August a death from cholera occurred and was followed by a second fatal case on the 20th. One of the hospital attendants on these cases was taken with the disease but recovered. The two fatal cases were recruits received from the Philadelphia rendezvous, and had been at depot not over thirty-six hours (in either case) when they were sent to hospital ill with cholera.

According to the statement of the chief clerk of the Philadelphia health office there had been thirty-one (31) deaths from cholera in the city of Philadelphia in the month of July, and two hundred and forty-six (246) in the month of August, the month in which these two recruits were enlisted. In September two men of the permanent company had non-fatal cases of cholera, immediately after their return from Jefferson Barracks, Missouri, where they had been as a part of guard on duty with a detachment of recruits sent from the depot. It will be remembered that cholera existed at Jefferson Barracks, and at the quarantine camp below those barracks, in that month. To reach Jefferson Barracks from Carlisle and to return to their station necessitated two distinct visits to the city of St. Louis by this guard. At the time of their visits cholera was virulent in those portions of St. Louis which soldiers, for even a short time off duty, would frequent. It is stated in the Medical Record of September 15th, 1866: "We find that St. Louis has been the heaviest loser in the Southwest, having already published a death-list approaching in round numbers nearly two thousand five hundred (2,500) as the result of a month's prevalence of the epidemic in a very virulent form." A sixth case occurred at Carlisle October 17th, in the person of a recruit who had arrived the previous day from the Chicago rendezvous (cholera being epidemic in Chicago) and terminated fatally on the 18th. In the person of the wife of a soldier another fatal case occurred at the depot. This woman had been in Rochester, N. Y., and was attacked with cholera shortly after her arrival at the barracks. From August to September inclusive eighty-six (86) cases of acute diarrhœa were treated.

On the 25th of August, three hundred and eighty-four (384) cavalry recruits from Carlisle Barracks arrived at Fort Riley, Kansas. They had come by way of St. Louis. On the 30th of August, a cholera death occurred among these recruits. The disease was confined exclusively to them, and did not spread to other troops at the post. Fifty-nine (59) cases of the disease with twenty-seven (27) deaths occurred, but from August to December (inclusive) 635 cases of diarrhœa were treated in the garrison.

At Fort Leavenworth, Kansas, the first case of cholera occurred September 18th. The patient died the next day. Altogether there were seven (7) cases with five (5) deaths at this post. From September to December inclusive 292 cases of diarrhœa (acute) were treated. These cases all occurred among troops recently arrived from other stations. The city of Leavenworth, two miles south of the post, was infected, but only about twenty (20) cases were reported.

On the 20th of November, a detachment of three hundred and fifty-six (356) recruits sailed from New York harbor en route for California. They reached San Juan del Norte, Nicaragua, December 8th, but on account of a rough sea they were not landed until the 15th. On the morning of the 16th the troops were placed on a steamer and proceeded up the San Juan river. The command up to this time was in perfect health. No communication was allowed with the shore. At 9 o'clock A.M. of the 16th, a soldier was taken with cholera and died the same day. At daylight of the 17th, five (5) other cases *were buried*. On the 17th there were four (4) cholera deaths; on the 18th three (3), and on the 19th two (2).

Reaching La Virgin, on Lake Nicaragua, a camp was made, as the command was obliged to await the arrival of a steamer on the Pacific. In this command fifty-four (54) cases with twenty-seven (27) deaths occurred. There was no cholera at San Juan when the troops landed; but, simultaneously with the outbreak among the troops, the passengers and native boatmen on another steamer were attacked. There had been no communication between these two boats, and the native boatmen on the passenger steamer had not been within two miles of the troops. The medical officer was confident that he had traced the epidemic to certain baggage which had been landed from the steamer at San Juan. This local epidemic on the shore of Lake Nicaragua was, it is believed, the last in which the disease could be traced back to depots in New York harbor.

A second focus from which cholera was diffused was established at Newport Barracks, Kentucky. Recruits were received at this point from Governor's Island during the continuance of the epidemic. But they were also received from rendezvous in cities where cholera was epidemic. They came from Detroit, at which city on the 29th of May, cholera deaths had occurred among emigrants; from Philadelphia, where the inception of the epidemic was on the 25th of April; from Cincinnati, almost daily from July 13th to August 12th; from St. Louis, where cholera appeared in the week ending August 3d, in frequent detachments; and from Chicago, where cholera appeared about July 21st, in the person of an emigrant.

On the 10th of July a detachment of recruits from Governor's Island arrived at Newport Barracks. No case of cholera occurred among them; but the day after their arrival (July 11th) a German woman who had accompanied these recruits died at Cincinnati on the opposite bank of the Ohio river, in a filthy tenement house. No cholera case occurred at this depot until August 12th when a recruit doing duty as a teamster, and who had been daily in Cincinnati, died of cholera. Nine (9) cases of cholera followed with five (5) deaths. From August to December (inclusive) one hundred and three (103) cases of acute diarrhœa were treated, with no deaths.

About the last of August or first of September, three hundred and sixty (360) recruits from Newport Barracks arrived at Nashville, Tennessee, and went into quarters near the Cumberland hospital. On the 2d of September three cholera cases occurred among these recruits; one case was fatal. About the same time the disease became epidemic in the city of Nashville, but in no way traceable to the movement of these recruits. Seventy-two (72) cases and forty-one (41) deaths occurred.

A recruit from Nashville was taken sick in quarters at Memphis, Tenn., with cholera, on September 6th, and died the next day. This case was followed by twenty-one (21) cases with sixteen (16) deaths among the troops; and one hundred and ten (110) cases of acute diarrhœa. A case had been landed from a river steamer on the 15th of August, and had died in the post hospital. The local epidemic in Memphis was not, however, occasioned by the arrival of these recruits.

The first fatal case at Little Rock Barracks occurred September 12th, and was followed by one hundred and thirty-eight (138) cases with sixty-six (66) deaths; with one hundred and fifty-eight (158) cases of simple diarrhœa. Recruits from Newport Barracks had arrived on the 15th of August, but it is not probable they were factors in the epidemic. It is presumable that the disease was carried from Memphis, Tenn., by Arkansas river steamers to Little Rock, and that the troops received the infection from that city. The epidemic at this point was much more intense among the troops than it was among the citizens of the town. From Little Rock, cholera was conveyed by river steamers to Fort Smith, Arkansas. Twelve (12) cases with four (4) deaths occurred, with one hundred and ten (110) cases of acute diarrhœa. At this point the epidemic was more severe among the citizens. According to the statement of Doctor Duval three hundred (300) cases were treated; the number of deaths was not reported.

At Fort Gibson, Cherokee Nation, a company of troops from Fort Smith, en route to Fort Riley, Kansas, arrived October 12th. Cholera prevailed at Fort Smith at the time of departure of the company. Three days after their arrival at Fort Gibson, two fatal cases of cholera occurred in that company. The soldier who acted as nurse was attacked but recovered. One other fatal case occurred during the month of November—a total of four (4) cases with three (3) deaths—and fourteen (14) cases of acute diarrhœa.

A detachment of recruits was sent from Newport Barracks (via Nashville, Tenn.) to Atlanta, Georgia, for assignment to companies. They arrived at Atlanta on September 9th, bringing with them two cases who developed cholera at Chattanooga, Tenn. Nineteen (19) cases with seven (7) deaths, and ten (10) cases of acute diarrhœa, followed.

At Augusta, Georgia, the disease appeared September 9th in the persons of recruits on the way to their companies. There were eight (8) cases with seven (7) deaths and fifty-six cases of acute diarrhœa.

The last record of cholera diffusion by recruits from Newport Barracks is at Helena, Arkansas, on the 30th of August. During August and September there were ten (10) cases of cholera, with six (6) deaths; and ten (10) cases of simple diarrhœa. A detachment of twenty-eight (28) recruits had been received at this post on the 3d of August. They are supposed to have been a portion of a detachment of recruits which left Newport Barracks, Kentucky, for Little Rock, July 28th.

In all military commands sanitary regulations were strictly enforced, and the influence of such measures, in the majority of instances, was marked in either arresting or stamping out the epidemic. This is notably the case in the military posts in New York harbor, in the immediate vicinity of a cholera-infected city, and in a harbor into which cholera-infected ships were constantly arriving from April 18th to November 28th. Originating in the person of a recruit on Governor's Island, the disease was conveyed in turn to Hart's and David's Islands. But at these three points the epidemic was confined by a cordon de sante, so far as surrounding posts were concerned. A single non-fatal case occurred at Fort Schuyler after contact with an infected steamboat, but at four other harbor posts no cases occurred. From New York harbor cholera was carried to Tybee Island; below the city of Savannah, but the disease was confined to the island; to New Orleans, Louisiana, where owing to the movements of emigrants it is impossible to determine whether the infection was due to the arrival of troops. The turmoil of political affairs in New Orleans demanded the presence of troops in all portions of the city, which at that time was in an uncleanly condition—every essential for the rapid propagation of the specific cholera poison was present, and cholera was carried to all military stations in the State. From New Orleans cholera was carried by troops to the State of Texas, arriving at Galveston and Indianola. Here the infection conveyed by troops joined the stream of infection conveyed by emigrants, and cholera overran the

State; and at military posts, having but a brief duration although costing many valuable lives. At New Orleans the steamers on the Mississippi river becoming infected, they in turn distributed the disease to troops when in transit. From New York harbor recruits were sent to Richmond, Virginia, where they were taken with the cholera, but it remains in doubt if the epidemic among the troops stationed at that point was due to the arrival of these recruits, or from contact with the cholera germ among the citizens of that city. From Richmond troops carried cholera to Yorktown, Fortress Monroe and Norfolk, Virginia, but no diffusion occurred. From New York cholera was taken by recruits to Louisville, Ky., and was carried by troops from Louisville to Bowling Green, Ky.

The recruits at Newport Barracks, Ky., received the cholera infection from rendezvous in the cities of Cincinnati, Ohio; Chicago, Illinois, and St. Louis, Missouri. What agency the movements of recruits may have had in infecting the city of Cincinnati cannot be determined. If the fact *can be fully received* that the cholera death in that city of July 11th was in the person of a woman who had accompanied a detachment of recruits from New York harbor, the agency must be admitted.

From Newport Barracks cholera was carried by recruits to Nashville and Memphis, Tennessee; and to Atlanta and Augusta, Georgia. At Nashville the line of cholera infection joined that ascending the Mississippi river; and successively Little Rock, Fort Smith, Fort Gibson, Helena, Jefferson Barracks, and perhaps St. Louis, were infected.

From New York harbor, cholera infection was undoubtedly carried by cholera-infected baggage to the San Juan river, Nicaragua; and as a result a cholera hospital for U. S. troops was established on the shores of Lake Nicaragua.

As a contrast to the story of cholera diffusion in 1866, and as an unanswerable argument to those who assert that this disease has established itself in the valley of the Mississippi and Ohio rivers, and who teach that as the Delta of the Ganges is the habitat of cholera, so is the Delta of the Mississippi, a few paragraphs from my cholera report for 1873 are here introduced:

In the early spring of 1861 the American civil war was inaugurated, and the United States was hurriedly converted into a vast military encampment. In all the cities that had been favorite haunts of cholera in former years, from the Penobscot to the Rio Grande, and from the Missouri to the Atlantic ocean, troops were collected, and vast armies were concentrated in the worst malarial regions of the United States, the valleys of the Potomac, Ohio and Mississippi rivers.

It is estimated that during the years of this war the United States army had in the field an aggregate of 2,335,942 men, or that the mean strength of the armies was about 783,906 men. These troops were in camp, constantly exposed to all the vicissitudes of the campaigns, or were in hospitals where, in spite of the lavish precautions which were adopted, ot infrequently all the disadvantages of overcrowding and deficient food were present. Vast numbers of men were transported to and from the scene of active operations upon steam transports. A very small percentage of the troops were in permanent fortifications. Vast prison pens were formed, in which overcrowding, bad ventilation, indifferent police, and unsuitable food were present to coöperate with local malarial influences upon the unfortunate prisoners.

The record of the medical history of the war demonstrates that there occurred in the army of the United States, of diseases of malarial origin, 1,468,410 cases, with 46,310 deaths; of intestinal diseases, 1,765,501 cases, with 44,863 deaths. Among the first are included typhoid, typhus, common continued, typho-malarial, yellow, remittent, the intermittents, and congestive intermittent fevers. Among the second are included diarrhœas, dysenteries and cholera morbus. Of the latter, during the entire war, there were reported but three hundred and five deaths.

It must be borne in mind that these figures represent but one arm of the United States service. When to these already large figures the statistics of the United States navy are added, and to this combination are added the statistics of the Confederate armies, the mass of circumstantial evidence is overwhelming.

In the very region where it is claimed that every epidemic of Asiatic cholera that has visited the United States from 1832 to 1873 originated, were these immense bodies of men congregated, and the exceeding mortalities occurred; yet, during all those years of bloodshed and suffering, *not one case of epidemic cholera occurred.* Why? *Because there was none of the specific poison of cholera, which is alone cholera, from which the disease might be reproduced.*

It was my fortune, during the epidemic of 1866, to witness a demonstration of the efficacy of stringent hygienic precautions, in protecting small communities from the inroads of cholera, as well as the portability, of the disease by means of cholera-infected clothing.

During the war, the Pea-Patch Island, at the head of Delaware Bay, upon which is located Fort Delaware, had been used as a prison for Confederate soldiers, of whom many thousands during the war had been confined at that point. All the available space outside the fortification had been covered by the buildings occupied as prisons and hospitals; and from necessity, after the large rate of occupancy, the island at the close of the war was in a most unsatisfactory sanitary condition. During the fall of 1865 and the winter of 1865–66, all unnecessary buildings were removed from the island, the ditches which traversed the island (the surface of which was below high-water mark) were drained and dredged. *Débris* of all kinds was collected and burned, and the island, at a very considerable pecuniary outlay on the part of the general government, was placed in a most perfect sanitary condition. In the latter part of August, 1866, a case of cholera occurred at Delaware City, the eastern terminus of the Delaware and Chesapeake canal, distant from Fort Delaware one and a quarter miles, from which town the garrison obtained its mail and supplies of all characters. The first case occurred in the person of a canal boatman, and spread to the inhabitants of the town, and a mild epidemic was instituted. Shortly afterward the town of New Castle, Del., Salem and Bridgeton, N. J., were infected with the disease, thus completely encircling the post within lines of cholera infection. By my advice the commanding officer at the post instituted a rigid system of isolation. But one boat, with a picked crew, was allowed to leave the island each day; and of this crew but one man, the coxswain, a most reliable and intelligent man, was permitted to enter the town. By this man the mail and all necessary supplies were obtained, and by this boat were conveyed to the island. The commissary department having been most liberally supplied, no stores in large bulk were required to be transported to the island. Although the epidemic during the season was so often carried into the towns that have been named, in the vicinity of Fort Delaware, as to institute two distinct epidemics, no case of cholera, or of any disease assimilating it, occurred upon the island, beyond the ordinary diarrhœa of the season, with but a single exception, which can be most satisfactorily accounted for. The isolation of the post which had been instituted had been most rigidly maintained, and, with the exception of the coxswain of the boat's crew already mentioned, no person but the post surgeon had been allowed to leave the island. As post surgeon, my services had frequently been asked during the prevalence of the epidemic; and the precaution always had been adopted of changing my clothing in an isolated shed upon one of the wharves every time I left and returned to the island. Convinced of the non-infectiousness of the disease by some instances which seemed to me to be inexplicable, one evening, on returning to the island weary and exhausted by a fatiguing day's work, I went, in the clothes in which I had been working over a cholera patient in Delaware City, to my quarters, undressed, and retired in the same room with my wife, at that time in extremely delicate health, and the clothing remained in her room throughout the night. The next day my wife had a diarrhœa which she allowed to continue for two days without calling my attention to it; upon the third day cholera was suddenly developed at an early hour in the morning; she became fully collapsed, and reacted only after the most severe struggle. Disinfectants were freely used, every means of isolation was employed, and no other cases occurred.

CHAPTER XV.

THE EPIDEMIC OF 1867 IN THE UNITED STATES ARMY.

FROM all obtainable evidence it seems that there was a "holding over" of the cholera germs from the subsidence of the epidemic of 1866, as had been the case in previous epidemics, to re-develop with increased virulence as the warm rays of the sun reached their "nidus" in 1867.

This was notably the fact as regards the cities of New Orleans, La., and St. Louis, Mo., and at the military station of Jefferson Barracks, Mo. At New Orleans the epidemic of 1866 continued until late in the month of December; perhaps it had not died out in the early days of January, 1867. It, however, reappeared in the month of June, 1867.

At St. Louis, Mo., the epidemic of 1866, lasted through the month of November, perhaps into December, and re-developed almost simultaneously with the New Orleans outbreak, in the month of June, 1867.

At Fort Gibson, Ark., the epidemic lasted into November, 1866, and re-appeared among the Indians and negroes who lived in the vicinity of that post during the last days of June, 1867.

At Jefferson Barracks, Mo., where in the post and the camp of the 56th U. S. Colored Troops a virulent epidemic of cholera, accompanied by a large number of cases of simple diarrhœa in August and September 1866, and where many cases of acute diarrhœa occurred during the remaining months of that year, a few cases of cholera occurred in July, 1867; but while Jefferson Barracks in 1867 did not suffer from an extended epidemic, it is an assured fact that a regiment of U. S. troops from that post—at which they had been organized and from which they were equipped for service—occasioned a most disastrous outbreak of cholera on the high, dry plains of western Kansas, and it is to this diffusion of the epidemic of 1867 that especial attention will be directed.

In view of the possible re-development of epidemic cholera, a system of stringent hygienic measures had been adopted at all military posts. That these measures were to a great extent effectual is evident from a study of the Report on Epidemic Cholera and Yellow Fever during the year 1867, by the late Surgeon J. J. Woodward, U. S. Army, from which report the following is taken: "At the majority of the points affected it (cholera) occurred first among the citizens and afterward appeared among the troops, but it was not always possible to obtain the date of the first case among the citizens, and hence it is not possible to assert that this was the invariable rule, though it is believed it was so." This remark cannot, however, apply to the Kansas diffusion of 1867, for in that year and in that locality all the facts point to the agency of troops, although the actual transportation of *recognizable* cholera was not at the time known to have taken place. The 38th U. S. Infantry (colored) was organized at Jefferson Barracks, Mo., early in the year 1867. Recruiting rendezvous for this regiment had been established in all the large cities, notably Chicago, Ill.; Cincinnati, Ohio; Philadelphia, Pa.; Baltimore, Md.; Louisville, Ky.; Nashville and Memphis, Tenn.; Vicksburg and Jackson, Miss.; Atlanta and Augusta, Ga.; New Orleans, La., and St. Louis, Mo. From these rendezvous an aggregate of over twelve hundred (1,200) recruits, mostly discharged soldiers from volunteer regiments, had been massed at regimental headquarters at Jefferson Barracks.

At Jefferson Barracks, during the time of occupancy by these troops, no case of cholera occurred, nor did a case develop until twenty-four (24) days after the last detachment of the 38th Infantry had left that post, but it is stated by Woodward that prior to this final movement of the regiment "a considerable number of cases of diarrhœa occurred" among the men. This regiment being destined for duty in the District of New Mexico, and the Indians on the Kansas prairies having opened hostilities by attacking parties of workmen along the line of the Kansas Pacific Railway, companies were sent forward to the line of that road, after having received their clothing and camp and garrison equipage from the storehouses at Jefferson Barracks. On March 20th Companies A and B, were sent forward and arrived at Fort Riley, Kansas, on the 24th, and remained at that post until May 13th, when they were ordered to Fort Harker, Kansas, arriving at that post on the 15th same month. Companies C, E, I, and G, left Jefferson Barracks on the 12th of May, arrived at Fort Harker on the 17th, where Company G took station (until June 5th, when it was marched to Fort Hayes, arriving June 15), while the other Companies (C, E, and I,) marched for Fort Hayes, Kansas, where they arrived May 28th. Company K left Jefferson Barracks on the 9th of June, and arrived at Fort Riley on June 12th; left Fort Riley June 19th, and arrived at Fort Harker June 22d. Companies D and F left Jefferson Barracks June 19th and arrived at Fort Harker June 25th. The regimental headquarters left Jefferson Barracks June 22d and arrived at Fort Harker June 27th. Each of these movements was made through St. Louis—by rail to Kansas City, Mo., thence by rail as far as the railway construction was completed, and by march from the termination of the track to the military stations named.

The first reported cholera case in Kansas during the epidemic of 1867 occurred in the person of a quartermaster's employee at Fort Riley, on the 22nd of June. Companies A and B of the 38th Infantry had been on duty at Fort Riley for fifty days (50), and Company K of the same regiment had been for ten days (10) at the post, leaving there on June 19th, three (3) days before the occurrence of the first cholera case. All these troops were suffering much from diarrhœa, and companies D and I, in passing Fort Riley, en route for Harker, had left a number of men sick with diarrhœa. (Woodward). The case of June 22d proved fatal in a few hours. Being casually at Fort Riley, I had an opportunity of inspecting this case. All the characteristic symptoms of malignant cholera were present, but owing to the energetic precautions of Surgeon B. J. D. Irwin, U. S. A., the disease did not become epidemic.

On the 27th of June, the headquarters 38th Infantry with Companies A, B, D, F, H and K were on duty at Fort Harker, Kansas, Companies A, B and K being on duty in garrison. The headquarters and Companies D, H and F were in camp a short distance southwest of the post. To the command in camp I was attached as medical officer.

On the 28th of June companies D and F (from the camp) left Fort Harker on the march for New Mexico, accompanied by Assistant Surgeon George McGill, U. S. A.

Owing to an interruption caused by washouts on the railroad, the full complement of medical and hospital supplies for this regiment had not been received at the date of departure of that detachment, and Doctor McGill had been supplied with all that had been provided for the camp of the regimental headquarters and the companies which should accompany it. I had ridden with the lamented McGill to the crossing of the Smoky Hill river, a few miles distant from camp, and on returning was asked by Acting Asst. Surgeon Ira Perry, U. S. A., to see with him a citizen employed by the beef contractor at Fort Harker. This man was in a "dug-out" close to a filthy slaughter pen about a mile south of the camp. It was a case of cholera, and the man died within a few hours. This case was the first indication of cholera being near the command. The same evening a man of Company H in the camp of the 38th Infantry was taken with cholera, and for lack of any means with which to treat him in camp he was sent to hospital at Fort Harker, where he died the next day. On the 29th a second case occurred, who was also sent to hospital at Fort Harker, where he recovered. On the 30th a third case was also sent to hospital in Fort Harker, where he died in a few hours. On July 1st five cholera cases occurred. The medical and hospital supplies for the 38th Infantry having arrived, these men were treated in camp hospital. On the 2d three (3) cases occurred in camp; on the 3d four (4) cases; on the 4th two (2) cases; on the fifth one (1) case, and on the 7th one (1) case. These cases were accompanied by fourteen (14) cases of painless diarrhœa. Of these cholera cases five (5) were fatal. From July 7th no new cases of cholera occurred in Company H. In the camp of the 38th Infantry, the most rigid precautionary measures were at once adopted, and as far as was possible the men were debarred from communication with the post. The water supply was brought from an isolated spring two miles distant from camp, and the privy sinks were carefully disinfected. All infected articles of clothing and bedding were destroyed by fire.

The first cholera case in Fort Harker occurred on June 29th, in the person of the child of a quartermaster's employee. This case occurred fifteen hours (15) after the first cases sent from Company H had been received in the post hospital. The same day the mother was taken with cholera (the child at 10 A.M., the mother at 12 M.), and the father was taken with the disease the next day. The cases of mother and child were fatal. The same day (June 29) a soldier from Company B, 38th Infantry (one of the companies serving in garrison) was admitted to post hospital with cholera at 6 o'clock P.M.[1] From these cases an epidemic originated which was wide-spread in the mortality and mental anguish which it occasioned. It will be seen that the epidemic was preceded by four distinct explosions of cholera, in individuals whose cases were not dependent upon each other. The employee of the beef contractor, distant fully a mile and a half from the camp of the 38th Infantry; the soldier of H company in the camp about one-third of a mile from Fort Harker (June 28th); the family of a quartermaster's employee who lived over half a mile from the preceding cases; and in the soldier in B company, then in garrison at Fort Harker (June 29th).

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[1] Report of Surgeon Geo. M. Sternberg, U. S. A.

This instance of cholera outbreak has always been a peculiarly interesting study to me. After eighteen years, the scenes of anguish and of heroic devotion to duty that I witnessed are as fresh to my mind as they were then. The solution to the problem of its introduction is, to my mind, to be found in the fact that the companies of the 38th regiment received their clothing and camp equipage at Jefferson Barracks; that such articles were infected with the cholera germ, and that when they were taken into constant use, from contact with them the disease was developed in the regiment. That from the same contact the acute diarrhœa which is reported to have been so prevalent among these troops was occasioned, and that owing to the hygienic precautions adopted the cholera germ contained in the diarrhœal dejecta did not obtain any suitable "hot-bed" in which the process of prolification could be accomplished until Fort Harker was reached, where, the post being in process of construction, all sanitary precautions had not been observed; for it was reported that "the police of the camps was not good when cholera first made its appearance. Some of the company sinks were in wretched condition, and there were several offensive holes about the post where slops and garbage from the kitchen had been thrown."[1] The water in use was obtained from a spring in the bank of a creek a quarter of a mile west of the post, and was stored in barrels for use.

Companies A and B had been on duty at Fort Harker for forty-three (43) days before the epidemic outbreak. They were in tents and were using camp furniture belonging to the post. Company K had been in camp six (6) days, Companies D and F had been in camp three (3) days, and the headquarters, with Company H, had been in camp two (2) days before the disease occurred. The regimental headquarters and companies K, D, F and H were in tents and using camp furniture brought from Jefferson Barracks.

There was a constant communication between the officers and men of the newly arrived troops and those who had served some time at the post. The newly arrived men could have, without infringement of duty, eaten with, drank from the same water, and used the same privies as were provided for their comrades. This access on the part of the men of the 38th Infantry, could readily have been extended to one company of the 37th U. S. Infantry (white), occupying a building within the post limits, a company of the 10th U. S. Cavalry (colored), in camp near post, the camp of quartermasters' employees, several hundred in number, who were at work in the construction of Fort Harker, and the camp of four (4) companies of Kansas militia who had been mustered into the U. S. service. All the circumstances were favorable for a virulent development of cholera, and the results of the epidemic fearfully demonstrated their presence.

As has already been stated, a detachment of the 38th U. S. Infantry marched from Fort Harker on the morning of June 28th. This detachment consisted of Companies D and F, who had left Jefferson Barracks, Mo., June 19th, arrived at Fort Harker June 25th, and who had left several diarrhœal cases at Fort Riley as they passed that post. At the close of the first day's march of this detachment a case of cholera occurred, and on each succeeding day until July 10th one or more cases occurred, giving a total of thirty-one (31) cases with twelve (12) deaths, the last case being on July 26th. The mean strength of this command was 232 men.

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[1] Report of Surgeon Geo. M. Sternberg, U. S. A.

By this detachment cholera was communicated to the troops serving at Fort Zara (June 29), Fort Larned (July 2), and Fort Dodge (July 7). By death from cholera, the medical corps of the army, suffered the great loss of Assistant Surgeon George M. McGill, Brevet Lieutenant-Colonel U. S. army, a most accomplished, devoted, self-sacrificing officer. On the 16th of July when a few miles west of Pretty encampment, a fortified stage-station on the overland mail-route, Mrs. McGill was taken sick with cholera. Finding it impossible to render his wife suitable assistance while the column was moving, Doctor McGill moved his ambulance off the road, established a solitary camp, and devotedly cared for her until the anguish was over; then, with his own hands, preparing her body for the grave, omitting no precautions which might preserve it from external injury, or which might in case of disinterment prevent the communication of the disease to others, he returned to Pretty encampment, where in person he superintended all the details of burial. Then mounting his horse, he endeavored to overtake the command; after riding some eighteen miles he was obliged to dismount by the roadside a victim to the disease, and in a few hours his earthly work was over. A purer, nobler heart is never to be found.

On the 10th of July, the headquarters of the 38th Infantry with Companies A and K took the road for New Mexico. Company H, which had been treated in camp, and in which cholera seemed to have been stamped out, was marched into Fort Harker, and two companies from the cholera-infected post where they had been constantly exposed to the epidemic influence, although both had been comparatively free from the disease, formed the column. Before leaving Fort Harker a rigid inspection of these companies was made. All suspicious cases were left, so that the command started with an absolutely clean sick report, and a most ample supply of all medical and hospital property. The command numbered two hundred and twenty (220) enlisted men, twelve officers (12) thirty-seven (37) ladies, children, and servants, forty-four (44) quartermaster's employees, and a family of ten (10) citizens—a total of three hundred and twenty-four (324) persons. On each day's march great care was taken to avoid all old camp-grounds. The first day passed without any sickness. On the second day a case of cholera occurred in a man of A company who had acted as nurse in the cholera hospital at Fort Harker, and when camp was made on that day (July 21), five (5) well marked cases of cholera and four (4) of painless diarrhœa were reported. These cases were isolated as far as was practicable and a strict surveillance over the command was instituted. None of these cases proved immediately fatal. July 22, the command moved to Walnut creek and camped on the east bank, for the reason that the entire line of the western bank for several miles was a defiled camp-ground, having been on constant occupancy by freight trains passing to and from New Mexico. During this day two cholera cases occurred, neither immediately fatal. July 23d the command was detained in camp, the stream becoming rapidly flooded (as occasionally occurs to prairie streams, without warning). Two new cases occurred, and two of the cases attacked on the 21st, died. The symptoms of all other cases of the disease, which been considered as passing to convalescence, deepened and many cases of diarrhœa were reported. At Fort Zara, one mile distant, a re-development of the disease occurred in the person of the officer commanding, who died after a few hours' illness. No communication occurred between the commands, except in the person of the medical officer. July 24th the command was still detained in camp. Eight (8) cases of cholera and five (5) of diarrhœa occurred. Two (2) cases died, one a man taken sick on the 22d, the other a case of the 24th. July 25th, the command crossed Walnut creek and marched to the bank of the Arkansas river, leaving the ordinary line of travel several miles to the north, taking a road which, on account of Indian hostilities, had not been used for nearly a year, and on which no trails or signs of camps were found. On leaving the camp on Walnut creek a very malignant case occurred in a man of Company A, who although he had not been reported sick, but marched out of camp in the ranks, was dead four hours later. The same day one case of those attacked the previous day died, and five (5) new cholera cases with fourteen (14) cases of diarrhœa occurred. The epidemic influence continued until the 30th of the month, when it subsided with the exception of an isolated non-fatal case which occurred August 10th.

It can be confidently asserted that this command was in no way responsible for any cholera diffusion after the line of march from Fort Harker was taken up. The moving hospital consisted of a fully equipped Autenrieth medical wagon, a very abundant supply of disinfectants, stimulants and hospital stores, a full supply of hospital tents, three ambulances and several army wagons. A close watch was kept over all individuals in the command. Every case of diarrhœa was promptly discovered and actively treated. No man suffering from diarrhœa in any form was permitted to continue in ranks, but was placed at once in an ambulance or wagon. On some days' march nearly the entire command was thus transported. A sanitary detail marching in rear of column prevented straggling. Any one compelled by necessity to fall out of line was taken under observation and his excreta was inspected by an intelligent assistant, who saw that the dejecta were properly disinfected and covered with fresh earth before it was abandoned. The march of each day was over before the heat became great; frequent halts for rest were made. Drinking water was taken from the Arkansas river—at that point a clear, swift-flowing stream. I find it recorded in my note-book of this time: "The effect of remaining in camp was evidently so pernicious to the morale of the command that it was decided to move camp each day, if enabled to make only a few miles. It is a noticeable fact that while daily marches were made, even in the unvarying scenery of the Arkansas valley, the morale of the entire command was unaffected; but, on the other hand, one day of rest, or even the prospect of remaining twenty-four hours in camp developed cases of choleraphobia."

The hospital camp was each day pitched to the leeward and at a sufficient distance from the camp of the troops. In this camp narrow pits were dug to receive the excreta and the water used in cleaning, everything before being emptied into these pits was thoroughly disinfected with carbolic acid, and after each use covered with fresh earth. All soiled articles of clothing or bedding were destroyed by fire. Before leaving a camp each pit was again disinfected by strong acid solutions and filled to the surface with fresh earth. The ambulances and wagons used in transporting the sick were daily cleaned and disinfected. Similar precautions were adopted in the main camp, where the men were kept under constant and close supervision by the company officers.

No communication was permitted between this command and any posts or stations along the line of march, save in the persons of the medical officer and quartermaster. In each instance the line of march diverged so as to leave the post at least two (2) miles distant, and in no instance was a camp made nearer any post in a less distance than three (3) miles. After crossing the Arkansas river and reaching the territory of New Mexico a quarantine camp was made for two weeks before marching into Fort Union on August 31st.

Among the enlisted men of this command, forty-six (46) cholera cases with seventeen (17) deaths occurred. One (1) fatal case occurred among the quartermaster's teamsters. Three (3) cases with two (2) deaths occurred in the family of citizens, and one (1) non-fatal case occurred in an officer's family, making a total of fifty-one (51) cases with twenty (20) deaths.

No cases of cholera occurred among the hospital attendants or drivers of hospital wagons or ambulances. The last cholera death among the citizens accompanying the command was on July 30th. The last cholera death among the troops of this command occurred on July 29th. The latest developed case among the troops was on July 28th. The last case in the entire command was an isolated non-fatal case August 10th.

The movements of Companies D and F and of Companies A and K have thus been accounted for. It has been shown that these companies left Fort Harker at dates nearly a month apart, and that it was by the first of these detachments that epidemic cholera was distributed to military stations on the line of march. It is interesting to observe the effect of the movements of the other companies of this regiment. Companies B and H remained at Fort Harker until after the subsidence of the epidemic. It will be remembered that H company had been moved from camp, in which it had undergone a thorough system of disinfection, to the garrison of Fort Harker when the regimental headquarters moved from that post. I was afterward informed by the captain of the company that no cases of cholera occurred among his men after the 7th of July. The remaining four companies of this regiment C, E, G, and I, were on duty from the 25th of May at Fort Hayes, Kansas, where on July 11th cholera occurred among them. This outbreak was, however, preceded by the death of a citizen who had just arrived from Salina, whither the cholera had been carried from Fort Harker. During July and August the disease was confined to the colored troops, but on the 1st of September the white troops were infected. From Fort Hayes and Fort Harker cholera was carried by the movements of troops to Downer's Station, Grinnell Springs, Monument Station, and Fort Wallace; and by the movements of the company of the 10th U. S. Cavalry cholera was carried into camps on Wilson's Creek and on the Little Arkansas river. From these troops, companies of the 3d, 5th and 37th Infantry, and the 7th U. S. Cavalry, were cholera-infected.

The special epidemic which followed the arrival of the companies of the 38th U. S. Infantry at Fort Harker, lasted during the months of July, August, September and the early days of October, and was distributed over the entire western portion of the State of Kansas.

The epidemic of cholera which broke out in June, 1867, among the negroes and Indians around Fort Gibson, spread to Company D, 10th U. S. Cavalry, and was by them in July carried to Fort Arbuckle, where a mild epidemic occurred. Early in the month of July, two companies of the 6th U. S. Infantry, en route from Fort Smith to Fort Arbuckle, passed over the road and perhaps used the camp-grounds that had been used by D troop, 10th Cavalry (the existence of cholera being unknown to them)

July 14th a severe epidemic occurred among them, and in a command of one hundred and twenty-nine (129) officers and men, forty (40) cholera cases with sixteen (16) deaths occurred.

On the 21st of August, 1867, a fatal case of cholera occurred on Governor's Island, New York harbor, in the person of a recruit who had been received the evening previous from St. Louis, Mo. In the detachment to which this man belonged one fatal case had occurred after the recruit had left St. Louis, and the man attacked after reaching Governor's Island had been in attendance upon him. No additional cases occurred on Governor's Island until August 31st, when ten (10) new cases occurred, the first four (4) being in persons of recruits who had been received August 28th from New York City, Jersey City and Philadelphia. At this station during the months of August and September thirty-five (35) cases of cholera with eighteen (18) deaths occurred.

At Fort Wood, Bedloe's Island, the first fatal case of cholera occurred August 25th in the person of a St. Louis recruit, who had been in contact with the cases on Governor's Island. During August and September ten (10) cholera cases with four (4) deaths occurred. In the movements of recruits from these depots to their regiments several isolated cases occurred at various points, but no diffusion of the disease occurred. One fatal case was reported at Plattsburg Barracks, N. Y., in person of a man who had contracted the disease on Governor's Island.

On the 23d of November a detachment of recruits numbering three hundred and ninety-eight (398) sailed from New York harbor on the steamer Raleigh, en route for Galveston, Texas, via New Orleans, La. On the 30th of November a second detachment numbering five hundred and nine (509) recruits sailed from New York harbor, for Austin and San Antonio, Texas, via New Orleans.

The steamer Raleigh reached New Orleans December 2d; no sickness on board. The troops destined for Texas were detained on board on account of the prevalence of cholera in the city; and on the 3d, having been transferred to the steamer W. G. Hewes, sailed for Galveston. December 6th, the Hewes arrived at Galveston having on board a number of cases of diarrhœa having rice-water discharges, one case progressing to collapse, but none had died. The troops were disembarked and placed in camp; but owing to bad weather, on December 9th they were transferred to the barracks of the 17th U. S. Infantry.

On December 11th the detachment of recruits who had left New York harbor November 30th, arrived at Galveston, after having been detained one day at New Orleans, (probably Dec. 7th or 8th). In this detachment one cholera death had occurred before reaching Galveston. After remaining one day at Galveston, they sailed for Indianola, Texas, leaving a number of cholera-sick. Among these men thirteen (13) cases with two (2) deaths occurred at Indianola, where the disease did not spread to other troops. At Galveston, cholera was carried to Hempstead, Texas, and from Indianola to camp near Austin, but the epidemic was of a mild type.

From New Orleans the epidemic of cholera affected slightly the garrison of Jackson Barracks; it was carried to Fort Jackson, Miss., Vidalia, La., Vicksburg, Miss., Madison, Ark., but owing to the stringent hygienic measures that had been adopted at those places in view of the approach of yellow fever, no extended epidemic occurred.

CHAPTER XVI.

THE EPIDEMIC OF 1873 IN THE UNITED STATES ARMY.

THE cholera epidemic of 1873 in the United States had but slight effect upon the troops serving within the limits of the epidemic influence. This epidemic was confined to, but prevailed throughout, the valley of the Mississippi and its tributaries. The early cases occurred in the city of New Orleans. From that city the disease was carried northward. Again were river steamers the active porters in the epidemic diffusion. Cholera became epidemic at all points attacked, although it assumed a pandemic form at once. During the entire season of epidemic influence the disease was governed by the same well-defined laws that had been presented by all other demonstrations, and the fact that the disease did not assume its accustomed epidemic violence in the larger cities, and that its most malignant demonstrations were confined to small country towns and villages, is alone due to the fact that the larger cities were protected by energetic health boards assisted by the active coöperation of municipal authorities, while in the small country towns the most culpable negligence was shown.

At many of the cholera-infected points, United States troops were stationed, but it was only at Monroe, La., Nashville and Chattanooga, Tenn., Lancaster and Lebanon, Ky., St. Louis Barracks, Mo., and Denison, Texas, that any epidemic influence was observed. In no way during the epidemic was cholera spread by movements of troops; but, in every instance in which it occurred among them the cases were traced to direct contact with cholera-infected citizens living near their quarters.

In this epidemic the efficiency of active hygienic measures and a strict system of non-intercourse (which can be most perfectly accomplished in a military command) combined with a radical stamping out of the disease whenever it may occur, was fully demonstrated.

Late in April, 1873, a large body of Tennessee convicts employed as laborers on the line of Memphis and Paducah railroad were attacked by cholera in their camp about twenty (20) miles out of the city of Memphis. On the 14th of May following the disease continuing, although comparatively but few deaths had occurred, the State authorities removed the convicts from their camp to the State Penitentiary at Nashville, and seventy-five convicts, the entire party suffering "*from diarrhœa, copious watery stools, accompanied in very many cases with nausea and vomiting,*"[1] were received in the prison, then containing three hundred and fifty (350) healthy prisoners. For the result of this importation of cholera the reader is referred to my narrative of the Cholera Epidemic of 1871.

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[1] Narrative of Cholera Epidemic of 1873 in the U. S., p. 148.

On the 22d of May cholera escaped from the penitentiary and seized upon the beautiful city of Nashville, where to July 1st, according to the statistics of Dr. W. K. Bowling, no less than six hundred and forty-seven (647) deaths occurred. Ash Barracks, situated on the northern suburb of the city, was garrisoned by the 16th U. S. Infantry, and as the epidemic assumed such grave proportions, the troops were moved from the barracks to a camp at White Creek Springs, twelve miles from the city. All communication between the camp and Nashville, with the exception of one reliable teamster who could be depended on to obey all instructions, was abandoned.[1] A detachment consisting of one officer and eight enlisted men remained as a guard at Ash Barracks. The family of the officer, thinking that in the empty barracks they would be perfectly isolated, insisted upon remaining with him. At the camp no epidemic influence was observed. At Ash Barracks a cholera death occurred in the family of the officer, and four non-fatal cases occurred among the enlisted men.

To Chattanooga, Tennessee, cholera was carried from Nashville soon after the disease became epidemic in the latter city, by employees on the Nashville and Chattanooga Railroad. The first local case occurred in the proprietress of a railroad boarding-house. On June 20th the disease was rapidly spreading through the city. Two companies of the 2d U. S. Infantry were stationed in barracks on the southeastern side of the city. One fatal case occurred in the command. It being impossible to find a suitable camp ground, on the recommendation of the medical officer, Asst. Surgeon Charles Styer, U. S. Army, "that the morals and hygienic condition of the command could be better preserved in the barracks than at an exposed camp," it was determined to remain in garrison. Every sanitary precaution was adopted to prevent introduction of the disease, and although one fatal case did occur, the germs were stamped out and no other cases followed the introduction. Dr. Styer, in his report, makes the following statement: "During the epidemic, so far as my recommendation went, the soldiers and officers and their families used such mature vegetables and fruits as could be obtained and properly prepared for the table in liberal though not excessive quantity. . . . . certain officers who could not free themselves from the influence of former teachings, confined their diet to ham and eggs, coffee, bread, and so on, and before the diarrhœa scare had subsided, had considerable trouble chiefly from diarrhœa in different members of their families."

At Lancaster, Kentucky, on August 10th a man, Bewley, who had recently arrived from a cholera-infected district in the State of Tennessee, was taken with cholera at the house of a friend, where after a lingering illness, presenting all the phenomena of a prolonged attack, he died on the twelfth day. The exereta of this case were not disinfected, but were thrown upon the ground in rear of dirty outhouses. August 14th a negro who nursed Bewley, and on August 15th, the father-in-law of Bewley, died of cholera, and a malignant epidemic was instituted. The man from Tennessee lived until August 22d, and his death was preceded by nineteen (19) cholera deaths, all of which were directly traceable to him. In this local epidemic, among other most interesting demonstrations of cholera peculiarities was an exhibit of the ability of the infectious principle to attach itself to inanimate objects, from which it can be transferred to the human organism with fatal effect. After Bewley's death, August 22d, the family left the house and the room in which the death occurred remained closed until September 20th, when it was opened and occupied by an old lady, in whose person cholera was rapidly developed and she speedily died.

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[1] This man was not permitted to associate with or to live among the men in camp.

One company of the 16th Infantry was doing garrison duty at Lancaster; the troops were camped on high ground east of and immediately adjoining the town. August 23d the company drummer and his wife, who lived in the rear of the captain's quarters outside of the limits of the camp, were taken with cholera within an hour of each other and both died within twelve hours. The clothing of this couple had been washed by a negro woman who lived in the infected district, and only a few hours before they were attacked the clothing had been returned to the owners. August 29th a soldier was taken with cholera and died within twenty-four hours, and the next day his comrade who occupied the same tent and slept in the same bunk also died. One of these men had nursed and assisted in preparing for burial the bodies of the soldier and his wife who had died on the 23d. The other was known to have frequented negro cabins in the infected districts.

August 30th the troops were moved to a new camp ground two miles from town. At this camp one cholera case occurred soon after the removal, but recovered.

At Lebanon, Ky., the epidemic of 1873 was preceded by the occurrence of several seemingly isolated cases. July 19, a fatal case occurred in a negro who had come from an infected house in Taylor county, Ky. August 11th, a negress, also from the infected district in Taylor county, died, and from that date to the 18th several suspicious cases were known to have occurred. From August 18 to the 25th five (5) seemingly isolated cases occurred, but all these cases with one exception resided upon or near a small stream which formed a drain for the town. Disinfectants were employed in none of these cases. The excreta were thrown into or on the bank of the drain, which was at that time almost dry. Upon the banks of this small stream and in the immediate vicinity of the houses in which the preceding cases had occurred, was a town well.

The Marion County Fair, which commenced August 26th, was held upon high and unwatered ground. Water from the indicated well was conveyed in carts and wagons to the fair ground. August 26th the water in the well was low. August 27th a violent rainstorm deluged the country, and this well, from surface washing, was filled to overflowing. During August 28th and 29th the attendance upon the fair was large. August 30th a cholera explosion occurred, and was at first confined exclusively to those who had been in attendance upon the fair. In all quarters of the town of Lebanon, in the most isolated portions of the surrounding counties, cases of cholera occurred with surprising rapidity.

One company of the 16th U. S. Infantry was doing garrison duty in the town. They were in comfortable barracks on high ground, and were supplied with water from a well which, fortunately, was so situated as to be beyond suspicion. As the command was in most admirable sanitary condition, and as cholera was so extensively diffused over Marion county, no advantage could be obtained by moving these troops. They therefore remained in barracks. But one case of cholera occurred in the command, and that in the person of a married soldier who had been permitted to live with his family in the town. No case occurred within the limits of the barracks.

On the last of May, 1873, a case of cholera was reported among the troops at Monroe, La., and in June another case was reported at the same post; both of these cases terminated fatally. No cases occurred at Jackson Barracks, or at the garrison near the city of Jackson, Miss., although cholera was epidemic among the citizens of New Orleans and Jackson.

At the Cavalry Depot, St. Louis Barracks, one case of cholera occurred July 14th, in a recruit who had recently joined, and who died after an illness of about ten hours. Every precaution was taken by Surgeon B. A. Clements, U. S. A., owing to which no other cases occurred, although a marked tendency to choleraic diarrhœa manifested itself. The narrative of the cholera epidemic of 1873 contains a statement of the sanitary precautions adopted, and as those portions of the city of St. Louis contiguous to the barracks were cholera-infected, the escape of the troops from the epidemic is surely owing to the precautions adopted by Dr. Clements.

But one cholera case was reported in 1873 among the troops serving in Texas, and that one was in the person of a man of the 11th U. S. Infantry while on escort duty from Fort Griffin at Denison, where the epidemic existed in some violence.

The authorities upon which this history has been written, are:

1. A Statistical Report on the Sickness and Mortality in the Army of the United States, prepared under the direction of Thomas Lawson, M.D., Surgeon-General, Washington, 1840, and which embraces a period of twenty years from January, 1819, to January, 1839.
2. A Statistical Report on the Sickness and Mortality in the Army of the United States, prepared under the direction of Brevet Brigadier-General Thomas Lawson, Surgeon-General, by Richard H. Coolidge, M.D., Asst. Surgeon, U. S. A. Washington, 1856, and which embraces a period of sixteen years from January, 1839, to January, 1855.
3. A Statistical Report on the Sickness and Mortality in the Army of the United States, prepared under the direction of Brevet Brigadier-General Thomas Lawson, Surgeon-General, by Richard H. Coolidge, M. D., Asst. Surgeon, U. S. A., Washington, 1860, and which embraces a period of five years from January, 1855, to January, 1860.
4. Circular No. 5, War Department, S. G. O., Washington, May 4, 1867. Report on Epidemic Cholera in the Army of the United States during the year 1866. By Brevet Lieut.-Col. J. J. Woodward, Asst. Surgeon U. S. A., Washington, 1867.
5. Circular No. 1, War Dept., S. G. O., Washington, June 10, 1868. Report on Epidemic Cholera and Yellow Fever in the Army of the United States during the year 1867, by Brevet Lieut.-Col. J. J. Woodward, Asst. Surgeon, U. S. A., Washington, 1868.
6. Report on Cholera Epidemic of 1873 in the United States, by Ely McClellan, M.D., Asst. Surgeon, U. S. A., Washington, 1875.

CHAPTER XVII.

CHOLERA ON SHIPBOARD.[1]

THE occurrence of epidemic cholera on board vessels in the U. S. Navy has been so infrequent and the preventive means have been so successfully applied, that the details of such outbreaks are meager.

Medical Director A. C. Gorgas reports that in January 1859, while anchored off Manila, in the East Indies, on board the U. S. S. Germantown, an outbreak of cholera occurred. Three cases made their appearance. The first and second cases died, the third one recovered, treatment having been successfully applied during the premonitory diarrhœal phenomena. Cholera existed on shore at the time, and the three patients had been on liberty. Attention was at once directed to all cases in which diarrhœal phenomena were present, and the greatest care was taken in getting rid of the excreta, and in the destruction of all bedding and clothing belonging to the patients.

Dr. Gorgas also reports that in March and April, 1867, while at Montevideo, S. A., on board the U. S. S. Brooklyn, one case occurred, not fatal. Cholera existed on shore and there had been communication with the shore by the patient. The Brooklyn went to sea. The usual preventive measures were enforced, and no further cases occurred.

Medical Director Thomas J. Turner reports that in October, 1867, at the Navy Yard, Philadelphia, on board the U. S. S. Potomac, an outbreak of epidemic cholera occurred. The officers and crew of the Potomac aggregated 300 men. There were 65 cases of the disease with 32 deaths. No cases of cholera were known to exist on shore in the city of Philadelphia, either before, at the time, or afterward. The origin of the disease is ascribed to the use of the Delaware river water, and the position of the vessel in the river a short distance from the outlet of a main sewer lends credence to this supposition. The measures used to prevent the spread were as follows: 1. Stopping at once the use of the river water for all purposes. 2. Isolation of all those affected with the disease. 3. Prompt attention to all cases presenting any diarrhœal phenomena. 4. The immediate removal of all ejecta and dejecta. 5. Free ventilation, cleanliness and dryness of the vessel. 6. The free use of limewash, carbolic acid and ferric sulphate in solution. The epidemic was ended within 60 hours from its outbreak. Its arrest was attributed to the prompt measures instituted by this officer and their military enforcement.

Dr. Turner formulated for the use of the National Board of Health

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[1] Memoranda kindly furnished by the Bureau of Medicine and Surgery, U. S. Navy Department.

(and his suggestions were published in the *Sanitarian* for June, 1883), preventive measures to be applied to vessels in the event of an outbreak of cholera at sea:

> "*Cholera at sea*—Isolate the patient, receive all the dejecta in receptacles partially filled with sea-water, or, if in a steamer, in such receptacles partially filled with fresh coal ashes from the fire-room, and then throw the mass overboard. The ashes contain iron salts, and in so far as the iron salts are present, are more or less disinfectant. Burn all clothing, bedding or like articles soiled by any of the ejecta. Bury overboard, and early. If the decks should be soiled with the ejecta, lime wash, and afterward scrape, and burn the scrapings. Inspect the water supply. Boil all used for drinking or culinary purposes. Use distilled water if practicable. Inspect food and cooking. Inspect all passengers and crew to discover symptoms of premonitory diarrhœal phenomena. More than one movement of the bowels per diem, under the circumstances, to be regarded as suspicious, and the person so affected kept under observation. The personal cleanliness of all hands to be insisted upon. The use of the cholera belt of flannel to be enforced. The cleanliness, dryness and ventilation of all inhabited apartments to be secured."

In the years 1877-78-79, during the prevalence of epidemic cholera at numerous ports on the Asiatic station, no cases occurred on any of the vessels composing the U. S. Squadron on that station, and there was a notable decrease of all diseases of the alimentary system attended with flux. This freedom from such disease movement is ascribed to the use of distilled water for all purposes on board the vessels on the station. It must be observed that the distilled water used on naval vessels is obtained by the distillation of sea-water. No water from the shore should be used on vessels provided with a distilling apparatus, and if necessity requires the use of water from shore, such water should be boiled, filtered and then aerated. This, with the preservation of perfect dryness and cleanliness of the vessel, affords the best means of protection.

The medical records of the U. S. S. Lackawanna report the appearance of cholera on board that vessel while at Calcutta in December, 1872, which was ascribed to the use of bad water. There were 5 cases and 2 deaths. The disease existed in the city at the time, and on the banks of the Ganges and Hoogly rivers. The prompt departure of the vessel, with isolation of the sick, and the usual measures of cleanliness and disinfection, terminated the outbreak on board.

Surgeon M. L. Ruth, U. S. Navy, reports from memory an outbreak of cholera on the *passenger ship* Florida, on her voyage from Havre to New York in the fall of 1866. The Florida, a screw steamer of about 3,000 tons, left Havre during the latter part of October, of the year mentioned, with a passenger list, including crew and officers, approximating 600 souls. After six days at sea epidemic cholera appeared. There were 157 cases with 45 deaths. The disease exhausted itself within twelve days. No cases of cholera were known to exist at Havre at the time of departure. The ship was overcrowded. Water in the tanks that were opened on the fifth day had been submerged in the tanks, and had also been taken from an infected source, as was afterward demonstrated. It was bad and brackish.

The sailing ship Mercury, which left Havre a day or two subsequent to the Florida, and whose tanks had been filled from the same source, had cholera appear when six days out, with, it was stated, thirty deaths. As the Florida's tanks had been filled six weeks before those of the Mercury, and as no cases were known to exist at Havre previous to the sailing of these ships, Dr. Ruth infers that perhaps from forty to fifty days is the time necessary for the development of the cholera germ in water, especially as it appears that in a few days after the departure of these ships cholera appeared at Havre.

On board the Florida there was no distilling apparatus, and when Dr. Ruth took charge, coincident with the isolation of the sick, as far as practicable the further use of water from the tanks was arrested, and only after boiling, filtration, aeration and mixing with red wine, was it allowed to be used. Attention was paid to the checking of the premonitory diarrhœa. No cabin passengers were attacked. The dead were buried without delay. After beginning the use of the filtered and boiled water the disease abated.

Dr. Ruth reports that in the late cruise of the Essex around the world the use of distilled water appears to have secured almost complete exemption from all forms of bowel disturbance.

Cholera appeared on board the U. S. S. Frolic, at Cherbourg, France, October 16th 1866; 7 cases occurred, with 5 deaths, among men who had been on shore. The crew consisted of 116 persons. October 20th the sick were transferred to the hospital ship Fort. The Frolic was fumigated by burning sulphur, and no more cases occurred.

The recent statistical reports of the health of the British navy (1883) show similar experiences to our own. Their vessels on the East India station have been attacked by cholera from the use of bad water by the crew on shore. The Espoir had 8 cases with 5 deaths at Foochow, China. "The men who were attacked had partaken of lemonade made by the Chinamen, the water for which was drawn from a well in the most infected part of the city." The vessel proceeded to Hong Kong without any other cases appearing, and was thoroughly disinfected there.

The Flying Fish gunboat had 7 cases with 2 deaths at Chefoo, China, where the crew were on shore on liberty. The vessel put to sea, and was cleansed and fumigated with the result apparently of ending the attack; but on reaching the Corea, two more cases occurred. The crew were then landed on a barren island, under tents, until a more thorough cleansing of the vessel was had and sulphur was burned in the hold and storerooms below. No more cases occurred.

> "With cholera prevailing, as it did, in Chefoo, when the habits of the natives are known, it is not difficult to trace the cause of the outbreak. The vegetables grown for the use of the town, among which are lettuce, cabbages and pumpkins, are watered with *the fresh excreta of the inhabitants* diluted with water; and the bread is made, and the milk, which is very plentiful, adulterated, with the water from 'one of the worst' wells in this filthy town. To the milk the medical officer specially attributes the disease; both the men who died of cholera were exceptionally large milk drinkers, and all the wardroom officers, who also drank milk freely, suffered from diarrhœa."

The following sanitary precautions in regard to cholera were established by the British Admiralty, August 3, 1866:

> "There appears to be little doubt in the present state of knowledge with respect to this disease, and hope of successfully combating it is very much limited to its earliest stage, that of the premonitory diarrhœa; and it is to the fact that patients rarely present themselves to the medical officers until that stage is past, that the great mortality it occasions is attributable. As no amount of experience on the part of the men themselves, and no advice given them, appears to be of any value in inducing them to present themselves at an earlier period, it will be necessary to institute such measures as may permit of a daily knowledge of the general state of health of the individual members of the ship's company, and of the men in barracks, being obtained. For this purpose my Lords direct—

"1. That the petty officers of messes be desired to exercise an unobtrusive watchfulness over the men composing their messes; that they report to the medical officer any man whom they may know, or have reason to suspect, to be laboring under diarrhœa, or who may appear to be in ill-health; and that it be impressed upon them that by evincing an intelligent interest in this direction they will do much to prevent any outbreak of cholera on board.

"2. Once daily, at least, at a time when the majority of the men are in their messes, a medical officer shall go round the different mess-decks and ascertain from the petty officers of messes whether there is any one requiring his attention.

"3. The officers of divisions, when inspecting their men, shall take notice of any man who may appear to be in ill health, and shall cause him to be at once taken to the sick-bay and reported to the surgeon.

"4. Twice daily, at least, the head shutes, as well as the shutes of the different water-closets in the ship which are much used, shall be washed down with a solution of chloride of zinc, in the proportion of one part of Burnett's solution of chloride of zinc to thirty of water, or chloride of lime may be freely used instead, and instructions shall be given to the captain of the head to report to the surgeon any man who, from making repeated use of it, may be suspected to be laboring under diarrhœa.

"5. Should cholera have established itself on board any ship, the utmost care is to be taken that the choleraic discharges, whether from the stomach or bowels, are largely mixed with the solution of the chloride of zinc or some other disinfectant before they are thrown away, and that any clothing or bedding contaminated with the discharges be destroyed.

PART SECOND.

THE ETIOLOGY OF CHOLERA.

BY

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OF NEW YORK.

CHAPTER XVIII.

GENERAL REMARKS AND SOME LEADING THEORIES ON THE NATURE OF CHOLERA.

In attempting to set forth the causation of cholera in as complete and satisfactory a manner as is compatible with our actual knowledge of the subject, it will not be possible to avoid entering into the land of theory and speculation. There is probably no other disease the etiology of which has been, and continues to be, so much in dispute as that of cholera. Heated discussions and prolonged controversies concerning its essential nature have, indeed, marked the history of the disease from its first appearance among us. At the present day the vast majority of competent writers agree that Asiatic cholera must have a special and distinct exciting cause. Ordinary agencies, general, local and individual, without the addition of this ultimate and essential something, are utterly inadequate to produce it. In other words, Asiatic cholera is always the result of specific infection. And from recent inquiries it seems probable that the carriers of the infection are certain particular micro-organisms discovered by Koch, and now generally known by the name of comma-bacilli. It may be well to admit at the outset that unless we accept Koch's theory, the special and essential exciting cause of epidemic cholera is still unknown. But before presenting an account of the German mycologist's doctrine, which assumes the micro-parasitic origin of the disease, it will be both interesting and instructive to review some of the leading theories that have been advanced regarding the nature of cholera.[1]

The Water-Miasm Theory of Bayer.—In 1832, M. Bayer[2] propounded a theory tracing the disease to a miasm which was contained in the water of tardy rivers and boggy pools. These pools and marshes liberate the miasm during the evaporation of water; the miasm then becomes mixed with the atmosphere, and thus produces the disease.

In countries surrounded by mountains and abounding in lakes and marshes, Bayer asserts that cholera prevails most severely. On the other hand in countries through which streams pass with some rapidity, where no stagnant waters are found, and where the foundation is rocky and the soil sandy, cholera has not made much impression.

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[1] It is as unnecessary as it would be unprofitable to examine critically all the multitude of etiological views on cholera that have at one time or another commanded the attention of the profession, nor has it been deemed advisable to enter into an elaborate discussion of all those doctrines which are here reproduced. In connection with most of them, however, sufficient comment will be made to fully acquaint the reader with the estimation placed by the editor upon them. The opinions of a few writers will be quite briefly summarized without comment, the reader being, of course, at liberty to draw his own conclusions. On the other hand, the writings of some authors will receive very ample attention.

[2] Henke's Journal of State Medicine for 1832 (Macnamara).

The power of the infectious matter evolved from the water with which it had combined is increased by the admixture of marsh miasms. So that, according to Bayer, the water of rivers will carry the matter in this compound state, and evolve it in different quantity and varying degrees of intensity, according to the activity of the powers causing its disengagement.

The theory of Bayer rests on assumptions and not facts. It has been discarded as untenable. Nevertheless it shows that contaminated water was early recognized as an active agent in the dissemination and propagation of cholera.

The Fermentation Theory.—An etiological doctrine frequently advanced may be called the old fermentation theory. According to this the action of the cholera poison is similar to the fermentative process. The germ of the disease is not in itself active. It must first undergo a change in which gaseous by-products, the true poison, are evolved. This process was assumed to occur in the ground, in such places as presented suitable conditions, and where a mixture of the "cholera principle" with the peculiar "soil principle" could be effected. It was compared to alcoholic fermentation, in which an indifferent fluid containing sugar is changed into alcohol through the action of a ferment. A catalytic force was supposed to be the agent causing such changes. The fungi of fermentation were unknown at that time, and hence this theory was a very ingenious hypothesis, lacking the support of actual knowledge concerning the true nature of fermentation. As will appear further on, Pettenkofer, even to the present day, upholds a theory that bears a decided resemblance to this old fermentation doctrine.

The Excrementitious-Poison Theory of Snow.[1]—In 1849 Dr. J. Snow asserted that the poison of cholera being swallowed acts directly on the intestinal mucous membrane. At the same time it is reproduced within the body and passes out, much increased in quantity, with the discharges. Afterward these discharges, chiefly by becoming mixed with the waters of rivers and wells, reach the alimentary canals of other persons, and give them the same disease.

According to Snow, the methods of propagation of cholera are four in number:

1st. Moist excreta on clothes and bedding of infected persons may be carried by the vapor of water and enter the nostrils and mouth and be swallowed. 2d. Dry excreta on infected clothing may be wafted a short distance by the air when the clothing is moved or unfolded. 3d. Nurses and those who attend the sick may introduce the poison into their system by not washing their hands before taking food. 4th. Utensils used by the sick and not properly cleansed may also contain the germs of the disease.

Snow's writings show that he was a careful observer, and although he remained in ignorance of the true nature of the infecting agent, he nevertheless should receive the credit of having ascertained the manner of its behavior, and a favorite mode of its dissemination.

The Cholerine Theory of Farr.—Dr. W. Farr, in 1852 stated that the disease was caused by a specific organic matter, the zymotic principle of cholera, which he called *cholerine*. He believed that "a variety of that matter was produced in India in certain unfavorable circumstances; it had the property of propagating and multiplying itself in air, or water, or food, and of destroying men by producing in successive attacks a series of phenomena which constitute Asiatic cholera." He says: "That cholerine is an organic matter cannot, I think, be doubted by those who have studied the whole of its phenomena and the general laws of zymotic disease. The great questions remain—Is cholerine produced in the human organization alone, and propagated by excreted matter? Is it produced and propagated in dead animal or vegetable matter, or mixed infusions of excreta and other matters out of the body? Is it propagated through water, through air, through contact, or through all these channels?"[1] He himself was unable to answer these queries. It appears, therefore, that Farr's views were rather unsettled and quite hypothetical. But as far as they went they were decidedly ingenious and suggestive.

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[1] On the Mode of Communicating Cholera. By J. Snow. London, 1849.

Kiehl's Theory.—A German physician, Kiehl,[2] who practiced in India for many years, believed the cause of cholera to be a contagion first formed in the human organism itself, altogether independent of climatic or other external influences. He says that the cholera of the present day arose in Jessore in 1817, and was thence spread by the flight from Jessore and by Hastings' army through Bengal. It gained access to Europe only through human intercourse, and was certainly not generated there. Prior to 1817 cholera existed only in India in endemic form, but at that time its nature underwent a complete change. The disease now became epidemic, and this metamorphosis is to be accounted for only by some alteration in the physical condition of the natives. The latter consisted in blood-poisoning induced by breathing vitiated air, the result of overcrowding. It occurred at the time of the fair at Jessore, during a season of deficient rainfall, when there was a scarcity of drinking water and a failure in the rice crop. In Europe cholera is never autochthonous, but is spread by a contagion existing in the breath or in the dejections of cholera patients.

Comment on Kiehl's theory is hardly called for. Yet it will be seen that, with certain modifications, his blood-poison theory received at different times a wide currency, and that even to-day the search for poisons in the blood of cholera patients continues. The similarity between the poison theory of Snow and the much later doctrine of Kiehl is apparent, as is also its resemblance to the views of Johnson, that will next occupy our attention.

Johnson's Blood-poison Theory.—This theory was at one time extensively accepted by physicians. But on the showing of competent and impartial writers like Macnamara, Simon and others, it appears quite untenable. In point of fact, at the present day it has but few supporters. According to Dr. George Johnson, then,[3] absorption of a miasmatic poison results in a primary alteration of the blood; that in turn leads to the characteristic phenomena of an attack of cholera.

Johnson believes that there is much evidence to show that the poison of cholera may be inhaled as well as swallowed. If inhaled, it must first enter the blood before it can reach the alimentary canal.

In a large number of cases of malignant cholera, constitutional disturbances precede the local intestinal manifestations; in other words, the disease has a period of incubation marked by malaise. The copious discharges from the intestines are the efforts of nature to eliminate the poison from the system and thus to cause recovery, and consequently if the secretion be checked, the risk of fatal collapse is greatly increased. The albuminous condition of the urine points to blood-poisoning, the fœtus in utero has been known to succumb to the poison, and characteristic discharges have then been discovered in its alimentary canal.

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[1] Report on the Mortality of Cholera in England in 1848–49. By Dr. W. Farr.

[2] Uber den Ursprung und die Verhüting der Seuchen. Erleutert durch das Beispiel der ansteckenden Cholera. Von W. F. P. Kiehl. Berlin, 1865.

[3] Notes on Cholera. By Dr. G. Johnson, London, 1866.

Johnson also maintains that the specific poison of cholera exercises an influence on the arterioles of the lungs and causes spasm of the muscular coats of these vessels. This leads to the imperfect aeration of the blood, and there is produced a venous congestion of the right side of the heart, and therefore systemic poisoning.

Relying on all these facts, Dr. Johnson administers purgatives, such as castor-oil, etc., in order to assist the action of nature in draining away the specific poison.

The results of the purgative plan of treatment as pursued by Johnson and his followers have not been such as to place his claims on the assured basis of empirical truth, whatever theoretical objections might be raised against the acceptance of the theory.

Moreover, Simon has pointed out that all the well-established facts of cholera are explicable on the assumption of a secondary blood-infection, resulting from the diseased condition of the bowels. Primary blood-poisoning Simon rejects as an untenable theory.

He says:

> "I do not find it proven, nor do I see any theoretical convenience in taking for granted that cholera begins as an active blood change capable of producing primary collapse. The facts, so far as I know them, can all be reconciled with the belief that cholera begins as bowel disease, producible by direct contagion, without even a passive intervention of the blood."

Further on he writes:

> "In questioning the fact of a primary blood-poisoning in cholera, I, of course, do not intend to deny that the blood *during* cholera is poisoned. From our earliest knowledge of the disease it has been on record that where pregnant women have cholera the intrauterine offspring almost invariably dies." [1]

The cause of the infant's death, he holds, has been shown to be true choleraic infection. Finally in the "Ninth Report to the Privy Council," London, 1867, Mr. Simon remarks that, "the notion of a primary blood-poison in cholera seems tending more and more to be superseded."

Macnamara also takes up Johnson's conclusions seriatim and points out that they do not accord with the facts, recognized as such by the best authorities.

It may be stated, however, that Johnson, in spite of these and many other adverse criticisms, still adheres to his former views. And quite recently, before the Royal Medical and Chirurgical Society, he read an elaborate argument in support of his doctrine.[2]

The Theory of Ilisch.—Decomposing-Dejections.—Ilisch,[3] an experienced Russian practitioner, maintained that the contagium of cholera is not given off directly from the bodies of the sick, but is formed by the decomposition of their dejections, when exposed to the action of the air. After the introduction of the contagium the epidemic arises independently of any telluric influences, provided only the diffusion of the poison is possible, and under all those conditions which especially favor putrefactive processes. When the cholera contagium comes in contact with putrefying substances a fresh supply may be produced by their decomposition. Whatever hinders putrefaction and decomposition (low temperature, abstraction of water and disinfection), hinders also the further production of the cholera contagium. This contagium may be carried from the sick to the well by the air, by water, or by handling objects soiled with cholera dejections.

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[1] Report on Public Health for 1866.

[2] The Lancet, March 28, 1885.

[3] Untersuchungen über die Entstehung und Verbreitung des Cholera-Contagiums, etc. Von F. Ilisch, St. Petersburg, 1866.

The views of Ilisch were at no time regarded with much favor by his confrères in Russia. Yet it will be seen that they are not unlike some of the more modern conceptions on the nature of cholera, as explained in the writings of authors of different nationalities. Even so competent an authority as Macnamara has propounded a theory that bears an unmistakable resemblance to the views of Ilisch.

Bryden's Monsoon Theory.—Dr. Bryden supposed the cholera contagium to be a miasm. He asserted that this miasm grew and flourished only in lower Bengal, in the delta of the Ganges and Brahmapootra. Here the disease had its endemic home. It was carried hence periodically in epidemic waves by the moist winds of the monsoon. He did not deny that cholera might be propagated through human intercourse, but still he regarded the atmosphere as the main channel of its diffusion.

Regarding the ultimate cause of the disease he had no definite opinion. Still, he thought it resembled in its behavior an organized vital body. It had periods of growth, existence, decay, revitalization, and final death. Time, place and atmospheric conditions were all so many factors that influenced its appearance and spread. The germs lay hidden in the ground. Under favorable local and atmospheric conditions their vitality was roused into full play. Currents of wind then propagated the active poison.

He maintained that the destructive epidemics were due to an "overflowing of the endemic boundaries" of the disease, as indicated above. It may be remarked that Bryden's views accord in the main with those of Dr. Beasley, of Midnapore (*Report on Cholera*, 1866–68).

The theory of Bryden is not tenable. Tested by the actual experience of numerous epidemics, it fails completely to afford an adequate explanation of the origin and propagation of cholera. Küchenmeister[1] has taken the pains to show that not one of Bryden's conclusions regarding the monsoons as carriers of cholera is in harmony with positive facts.

The Ozone Theories.—A German writer, Stiehmer, advanced the theory that cholera was due to a deficient supply of ozone in the atmosphere, and the same theory in a somewhat modified form was revived at a later period by Lender, also a German. Other writers have published similar views.

The ozone theories were at one time subjects of serious consideration on the part of the medical profession. They are merely mentioned here as illustrating the vagaries into which physicians have fallen with regard to the etiology of cholera.

The Organic-Dust Theory of Von Gietl.—In a monograph on cholera embodying the results of experience gained in many epidemics Von

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[1] Handbuch der Lehre von der Verbreitung der Cholera, etc. Von Dr. F. Küchenmeister. Erlangen, 1872, pp. 273–304.

Gietl[1] announced his conviction that the cholera virus was contained in the intestinal discharges, and that it was capable of speedy reproduction. He also showed that persons having diarrhœa, without experiencing any particular pain or discomfort, might nevertheless start an epidemic. He mentions the fact that many toxic substances may produce choleraic symptoms. A differential diagnosis based on symptoms is not possible. Virulent Asiatic cholera can only be recognized as such when several cases occur in quick succession. The cholera poison having entered the body from without, abstracts large quantities of fluid from the system of the patient, by its action upon the gastro-intestinal mucous membrane. It retards the flow of blood and the current of vital juices, and finally stops their movements completely. These disturbances explain the terrible phenomena of the disease.as well as the speedily fatal issue. Organic dust is the carrier and disseminator of the cholera-poison. Like all other dust, the cholera-dust does not enable us to recognize the virus through any characteristic shape of its own. We find the same condition of things in other diseases; for we are unable with the aid of chemistry and microscopy to differentiate healthy pus from that tainted with farcy, variola, or syphilis.

Von Gietl was a close student and careful observer. Yet, in spite of all this, as well as his extended experience, he was led into the gross error of formulating a hypothesis that receives no support even from his own observations. It seems strange that he should take refuge in so baseless a view as his dust-theory, after having clearly demonstrated the infectious nature of cholera dejecta.

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[1] Grundzüge meiner Lehren über Cholera und Typhus. München, 1875.

CHAPTER XIX.

PARASITIC THEORIES.

We come now to a number of doctrines that may be considered under the common heading of parasitic theories. They are peculiarly interesting on account of their recent revival, in principle at least, by the announcement of Koch's views. It has been thought advisable to devote a separate chapter to their consideration.

Boehm,[1] in 1838, described and pictured various forms of cryptogamic growth seen amid the débris of cholera dejecta. After death from the disease he found that the bowel contents teemed with vegetations of micro-fungi, and that innumerable round, oval, or elongated corpuscles were to be found in all the vomits and dejections, as well as in the intestinal canal; sometimes single, sometimes two, three, four, or more, joined end to end, as links of a chain.

In the microscopical examinations of rice-water dejections made by Parkes in 1848, he observed peculiar granules and corpuscles which he did not at first suspect to be of a vegetable or fungoid nature. But he found large numbers of vibriones. After the appearance of the drawings and descriptions by Klob, Thomé and Hallier, Dr. Parkes stated that his granular bodies were identical with the corpuscles of those observers. He said further that he found the same bodies in 1849, in 1854, and again in 1865, and that they constituted the major part of the flocculi of true rice-water stools.

The "annular bodies" or "cholera-cells" detected by Brittan[2] and Swayne[3] in the Bristol epidemic of 1849, and in part confirmed by Bennett of Edinburgh, properly belong to the category of alleged discoveries of cholera-organisms.

These cells, annular bodies, or corpuscles, are described as follows: "They vary very much in size and apparent structure during the different stages of their development. The smallest are of the same size as, or even much less than, blood-globules, so that to show them properly an object-glass of high magnifying power, such as one-eighth, one-twelfth, or one-sixteenth of an inch, is required; their walls refract light powerfully; fragments of them present the appearance of small segments of circles."

In this connection mention must be made of a paper which Mr. Fowke has quite recently read before the Royal Microscopical Society, entitled "On the First Discovery of the Comma-bacillus of Cholera."[4] In this paper he attempts to show by quotations from the writings of Drs. Brittan and Swayne, as well as by drawings reproduced from their original figures, that those gentlemen are entitled to priority in the matter of the discovery of the cholera-bacillus. He writes:

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[1] Ueber das Vorkommen der Gährungskeime (Pilze) im Nahrungskanal der Cholera-Kranken, quoted in J. Simon's "Report to the Privy Council for 1866," p. 518, and Die kranke Darmschleimhaut in der Asiatischen Cholera, etc. Berlin, 1838.

[2] London Medical Gazette, 1849.

[3] London Lancet, October 13, 1849.

[4] The British Medical Journal, March 21, 1885.

> "The results of Dr. Brittan's separate observations are very remarkable. He examined a series of cases, from 3 to 20 inclusive, and published the results in his table in the *Medical Gazette*, for 1849, vol. xliv., pages 530 to 542. Dr. Brittan found some peculiar corpuscles to be constant in the intestinal discharges of cholera-patients; and similar bodies, but smaller, though well defined, were discovered by him in the matters vomited; they appeared larger and more compound in the dejections; decreased as the disease progressed favorably, and vanished with the disappearance of the symptoms. Dr. Brittan afterward examined, under the microscope, specimens of healthy fæcal matter, and the fluid stools of typhus, typhoid, and other diseases, but failed to detect anything corresponding with the peculiar corpuscles belonging to cholera-dejections, though he discovered these bodies in cases of severe choleraic diarrhœa. From these observations, he inferred that the bodies in question were peculiar to cholera, and bore some essential relation to the disease."

But interesting as "this page of forgotten history" undoubtedly is, it does not appear in the least established, as Fowke maintains, that "the comma-bacillus was known and recognized so far back as thirty-five years since, the discovery being made by two Englishmen, Drs. Brittan and Swayne." Fowke himself seems to feel this, for, says he, "I am aware that objections may be taken as to the exact shape, size, etc., of the organisms figured, and the ordinary appearance of the comma-bacilli of Koch." But it is certainly quite interesting to remember that "peculiar corpuscles" resembling Koch's comma-bacilli were long ago found in the dejections of cholera patients, and long ago supposed to bear some "essential relation" to the disease.

In the same year (*i. e.* 1849) Dr. W. Budd, of Bristol, expressed his belief that the disease depends on a living organism, which being swallowed, becomes infinitely multiplied within the alimentary canal. The morbid action thus set up produces the flux and other symptoms of cholera. This organism was described as a distinct species of fungus.

Budd believed these fungi to be disseminated by contact with food, but especially through the drinking water of infected places.

Dr. Lauder Lindsay,[1] in 1854, found large bodies, which from their alleged resemblance to the gonidia of lichens he called gonidic corpuscles. He described these gonidic bodies as globular, colorless, nucleated, and larger than leucocytes. Around the central nucleus a number of spherical granules of a bright greenish-yellow or orange color were aggregated. He states that he discovered them in the stools of all his cholera-patients.

In 1856 Dr. Thomson[2] and Mr. Rainey stated that they had found in the atmosphere of a ward filled with cholera patients particles distinctly having life, and showing growth and movement: small flocculent masses, fungi, bacteria, and vibriones; and so abundant were these as to cover some of the larger branching fibers of the mycelium.

Three German professors Hallier,[3] Thomé,[4] and Klob[5] asserted that they had found in the dejections of cholera patients as well as in the intestines of those dead of the disease, certain bodies of definite structure, belonging to the class of fungi. They believed them to contain the active poison of the disease, which gained admittance to the body in drinking water, and thus acted directly upon the intestinal mucous membrane. According to them these bodies were made up of fine granules occupying a gelatinous substance. By subdivision they formed beaded threads, which interlacing produced a reticulum within the intestinal mucus. Hallier and Thomé also grew and cultivated these corpuscles and ascertained that they developed into larger spheres, resembling cells, which again rapidly multiplied. Rounded spores, growing on thread-like fungi, were also described by them in connection with these supposed cholera-corpuscles.

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[1] Edinburgh Medical and Surgical Journal, 1854.

[2] On the Chemical Conditions of Cholera Atmospheres. Lancet, 1856.

[3] Das Cholera Contagium. Botanische Untersuchungen von Dr. Ernst Hallier. Leipzig, 1867.

[4] O. W. Thomé, Cylindrotænium Choleræ Asiaticæ, ein neuer in den Cholera-ausleerungen gefundener Pilz. Virchow's Archiv. vol. 38.

[5] Pathologisch-anatomische Studien ueber das Wesen des Cholera-Processes, von Dr. J. M. Klob. Leipzig, 1867.

At the International Cholera Conference, which met in 1867 at Weimar, Professor de Bary, the distinguished German botanist, read a statement in reference to the observations of Thomé, Klob and Hallier. He pointed out[1] that these observers had failed to demonstrate that the fungi held by them to belong to cholera alone, were sufficiently well characterized to enable one to differentiate them from similar organisms seen elsewhere. Klob, Thomé, and Hallier participated in the conference, but appeared to be unable to substantiate their claims regarding the specificity of the organisms described by them.

Intestinal fungi, alleged to belong to cholera, were likewise described by a number of other observers, and variously characterized as cocci, rods, elongated threads, chains of rods, beaded threads, or zoöglea masses, etc. Among these observers may be mentioned Cohn,[2] Weiger,[3] Levis,[4] and Falger.[5] Naturally enough the fungus theory found many upholders. But it also met with very violent opposition. The opponents claimed that the micro-organisms found in greater or less number in the human cholera-intestine were developed there secondarily, in consequence of the changes caused by the disease. The intestinal mucous membrane, it was said, offered in this affection a specially favorable soil for the growth and development of vegetable parasites. Virchow and Hoffmann[6] found vast numbers of such fungi in the intestines of animals poisoned with arsenic, and other observers claimed to have seen the same organisms in many different diseases. So, too, Trautmann,[7] as long ago as 1869, claimed to have shown that the vegetable parasites of cholera, which he called decomposition-corpuscles, were indistinguishable from ordinary putrefactive organisms. Moreover, they were present in healthy dejections, and contained no specific contagious principle. The gases of decomposition were, he thought, the main agencies producing cholera.

It is interesting to compare the objections raised against these primitive parasitic theories with some very similar objections made in connection with Koch's recent doctrine. Perhaps it is on this account, so confidently asserted by the skeptics, that Koch's teachings, like those of Hallier and the other writers mentioned above, represent but a short-lived phase in the attempted solution of a problem that it would be vain to pursue further. Such views are as unscientific as possible, and if not energetically combated would hopelessly cripple all further investigation. Fortunately they are not entertained by a majority of those whom we most confidently rely upon for active scientific work in biological matters. But we cannot stop to enlarge on this topic here, except in so far as to reproduce the often-quoted views of Lewis and Cunningham. As a preliminary it may be stated that the repeated assertions regarding the discovery of specific fungi, capable of communicating cholera, finally led the British Government to select Drs. Lewis and Cunningham to make a special inquiry into the subject. This was of course long before Koch's era. In 1868 they went to India, and a number of articles giving the results of their investigations appeared in the *Reports of the Sanitary Commissioner with the Government of India* for 1869 and 1873. The conclusions which these English investigators arrived at are embraced in the following sentences:

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[1] Verhandlungen der Cholera-Conferenz in Weimar am 28 und 29 April, 1867. München, 1867, pp. 51–53.

[2] Beiträge zur Biologie der Pflanzen.

[3] Ueber die Cholerapilze. Quoted in Gaz. Hebd., 1868.

[4] Bericht über die Choleraausleerungen, 1870.

[5] Der Ansteckungsprocess der Cholera, 1867.

[6] Arsenikvergiftung und Cholera, Archiv. für Pathol. Anat. Berlin. 1870.

[7] Die Zersetzungsgase als Ursache zur Weiterverbreitung der Cholera. Von Dr. Trautmann. Halle, 1869.

1. No "cysts" exist in choleraic discharges which are not found under other conditions.
2. Cysts or sporangia of fungi are but very rarely found under any circumstances in alvine discharges.
3. No special fungus has been developed in cholera stools, the fungus described by Hallier being certainly not confined to such stools.
4. The still and active conditions of the observed animalculæ are not peculiar to this disease, but may be developed in nitrogenous material even outside the body.
5. The flakes and corpuscles in rice-water stools do not consist of epithelium, nor of its débris, but their formation appears to depend upon the effusion of blood-plasma; and the "peculiar bodies" of Parkes found therewith correspond very closely in their microscopic and chemical characters, as well as in the manifestations of vitality, to the corpuscles which are known to form in such fluid: these are generally to a greater or less degree associated with blood cells, even when the presence of such is not suspected, especially as the disease tends toward a fatal termination, when the latter have been frequently seen to replace the former altogether.
6. No sufficient evidence exists for considering that vibriones, and such like organisms prevail to a greater extent in the discharges from persons affected with cholera than in the discharges of other persons, diseased or healthy. But that the vibriones, bacteria and monads (micrococcus) may not be *peculiar in their nature*, and may not be the product of a peculiar combination of circumstances, able to give origin to peculiar phenomena in predisposed persons—is not proven.

In this connection the fact that in our own country, the late Dr. J. K. Mitchell, writing more than fifty years ago on the "Cryptogamic Origin of Diseases," almost anticipated our modern "germ theory," deserves also to be remembered.[1]

The vibriones described by Pouchet in 1849, the cercomonas of Davaine, and the micro-organisms discovered by Pacini in 1854, all harmonize, so far as the parasitic theory of the disease is concerned, with the modern doctrine of Koch. And this statement applies in a still more marked degree to

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[1] In a recent paper on the "Relations the past Investigations bear to the modern," Dr. Sharp, of Kansas City, after a review of Koch's doctrine, says (The Kansas City Medical Index, January, 1885):

"It is apparent that the results of modern investigation are but the logical conclusion of what has gone before. After the very first epidemic in this country in 1832–3–4, Drs. Mitchell and Daniel Drake announced the hypothesis that cholera poison was a micro-organism. And every subsequent epidemic has brought forth advocates of such an hypothesis."

So that Drake, as well as Mitchell, is entitled to whatever credit belongs to the early promulgation of a theory which later researches have rendered an extremely plausible one.

The Researches of Nedswetzky.—For in 1874 this writer positively asserted that Asiatic cholera was a bacterial disease.[1] He made numerous experiments and finally came to the conclusion that its parasitic origin could not be questioned. According to him various bacteria are always present in the *fresh dejections* of cholera patients, in the vomited matter, urine, and even in the exhaled breath. The blood likewise contained movable granules that he supposed to be specific micro-organisms. He also made numerous culture experiments (of a very primitive kind, of course, and without any attempt to isolate particular microbes), which showed nevertheless, that the various minute organisms seen by him were capable of growth and reproduction outside of the human body. The essential parasitic corpuscles of cholera fluids were described by Nedswetzky as of various kinds. He even mentioned small vibrios, "which while moving showed a kind of serpentine undulation, and *in shape resembled a curved comma*."[2] Yet it is evident from Nedswetzky's own descriptions that these comma-shaped bodies were merely the vibrios and spirilla ordinarily seen in putrid albuminoid substances, and that they had no relation to the much more minute comma-bacilli of Koch. It has been thought advisable to point out this radical difference between Nedswetzky's commas and those of the German mycologist, in order to forestall the possibility of priority-claims such as have been quite recently made in behalf of Pacini's granules. It is nevertheless strange that the bacteriological researches of this author have been so generally neglected by the majority of recent writers, since his ideas in many respects are thoroughly in unison with those of the present day, as advanced by Koch. It is for this reason mainly, and not on account of their intrinsic importance, that some of the views and deductions formulated by Nedswetzky are here summarized.

Among other things he says that four kinds of cholera-bacteria (*Cholera-Bacteridien*) have been described:

1. A granular substance, found in conglomerate heaps, and made up of the most minute compact cells that remain motionless. This substance is identical with the micrococcus of Hallier, and the granular punctate bodies of Klob.
2. Bacteria in the form of chaplets. They are in motion, and resemble the variety just described, but are rather larger. They occur in pairs or are found strung together in chaplet form.
3. Long bacteria, composed of attenuated threads, and resembling ordinary bacteria.
4. The organisms of the fourth class had been previously described by the author as spindle-shaped bodies. But on careful examination they were found to be composed of individuals of the third class placed so closely together as to simulate a single organism.

Nedswetzky also found that completely drying the cholera dejections destroyed the vitality of the cholera-bacteria. On the other hand, boiling the fluids in which they were contained did not kill them. This last assertion may be held to indicate the crudity of experiments of this kind as conducted only ten years ago. It is quite probable that Nedswetzky was led into erroneously assuming the well-known Brownian movements of all dead molecular matter to indicate retained vitality. So, too, his further experiments regarding the action of various drugs on the viability of his cholera bacteria are without value, and have to-day a merely historical significance. The following assertions made by the same writer contain views that will be read with interest even at the present time.

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[1] Zur Mikrographie der Cholera. Von Dr. Eduard Nedswetzky, Dorpat, 1874.
[2] Loc. citat., p. 13.

"The chemical agent producing fermentation and putrefaction has not hitherto been isolated, because it is a product of the vital action of minute organisms. For the same reason the cholera poison has not yet been discovered as a separate substance.

"The cholera-bacteria are found in such numbers in the bodies of cholera patients that even if we do not assume them to generate an infectious principle, their presence must still have a prejudicial effect upon the health of the sufferer, or may even lead to death."

The author finally advances the following propositions:

1. The presence in the body of such large numbers of parasites must necessarily excite some morbid action, as is clearly shown in other parasitic affections.

2. In the case of the bacteria in question this morbid action is invariably identical with the cholera process, and no other disease is caused by them.

3. Apart from the presence of these parasites, no other causative agencies are discoverable to account for an attack of cholera.

4. Whatever favors the development of these bacteria, also favors cholera. So that we may conclude that the causal relation between the origin of the one and the appearance of the other, is extremely probable. While as previously stated Nedswetzky's researches seem to have been forgotten,

The Discoveries of Pacini have led to numerous recent attempts to vindicate for the illustrious Italian priority over Koch in the discovery of the specific cholera microbe.

Before examining the claims made in behalf of Pacini by several of his countrymen, we may briefly examine his own statements. This was a matter of some difficulty, even quite recently.

But a short time ago Dr. Aurelio Bianchi caused to be printed from the original manuscripts of Pacini a number of observations never before published.[1] So that we are now able to form an estimate of Pacini's opinions from his own writings. These comprise notes of autopsies and of microscopical examinations of the tissues, and intestinal discharges and vomited matter, made in 1855 and 1867. Pacini mentions in many places the occurrence of erosions of the intestinal mucous membrane, which he attributes to the action of specific micro-organisms, called by him vibriones. He describes these vibriones in the following language:[2]

"The vibriones which are found in the fluids of cholera patients, seen under a high power of 800 to 1,000 diameters, resemble perfectly a fragment of fibrilla from striated muscular fiber. Indeed every vibrio appears as a series of very minute globules, as a rule clearly visible with this power. Sometimes they are less clearly seen. The smallest of these vibriones are made up of two or three globules (those of a single globule can not be distinguished from other molecules of the same size). I have also seen them formed of many more globules, even twelve or eighteen. When formed of six or seven globules they are not exactly straight, but a little curved. Those of ten or twelve globules are usually slightly bent in the shape of an S, or in some other shape.

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[1] Prof. Filippo Pacini, Nuove Osservazioni Microscopiche sul Colèra. Memorie Inedite, Raccolte e Pubblicate per Cura del Dottor Aurelio Bianchi. Milano, 1885.

[2] Loc. cit., p. 18.

"The vibriones in which the globules are not very distinct are *almost* perfectly straight. Perhaps the formation into globules and the incurvation may be the beginning of division. One of these vibriones made up of four globules was 5mmm. in length and the diameter of the globules was a little less than 1mmm."

The studies made in 1855 were always upon fluids and tissues previously treated with corrosive sublimate, and hence living micro-organisms were not described. This treatment was rendered necessary by an order at that time in force which forbade the removal of any specimens from one room of the hospital to the other, without such disinfection. In 1867 Pacini was enabled to study the living vibriones and described their movements. He also at this time made cultures of the microbes by adding a few drops of the intestinal fluid to an albuminous solution contained in flasks.

Apart from all controversial matter, this publication contains views and statements that will be read with interest.

In a communication made to the Section of Hygiene, at the International Medical Congress, in Copenhagen, August 11, 1884, Professor Tommasi-Crudeli presented arguments in favor of upholding Pacini's claim to priority in this matter.[1] In 1854, he stated, Pacini described a *microbe cholérigène* which attacked the intestinal mucous membrane, and, multiplying there, destroyed its epithelium.[2] This microbe (which was not called a bacillus, since nobody had then thought of classifying the schizomycetes) was declared by him to be the cause of cholera. He found it constantly in the intestinal mucous membrane, and in the dejections of cholera patients, during a long series of observations made by him in 1854–5 and again in 1865–7. He asserted that this microbe multiplied outside of the body in excrementitious matters, and called attention to the danger residing in linen soiled with choleraic discharges, and also to the possibility of infection through drinking water containing the parasite. The ultra-epidemic school of Florence rejected these ideas almost contemptuously, and in a reply to their strictures made in 1865, Pacini used these almost prophetic words: "When my discovery shall have made the tour of Europe and shall have returned to Florence from without, it will be permissible to cite it in our schools; but when that time comes I shall be no more." And, indeed, Pacini died some months before Koch's journey to Alexandria. There were some, however, who thought Pacini's discoveries worthy of serious consideration, and among them was the author of this communication. While by no means accepting them as conclusive of the parasitic nature of cholera, Tommasi-Crudeli believed that the presumption was strong enough to warrant the adoption of such measures as would be undertaken were it an established fact. Acting upon this presumption, during the epidemic at Palermo in 1866, he established a municipal laundry to which the soiled linen of cholera patients was carried in vessels containing a solution of chloride of lime or carbolic acid. To this laundry was brought all the linen from the public institutions and from a number of private houses, but not one of the employees of the establishment was attacked with cholera. At another laundry, however, located a short distance from Palermo, to which soiled linen without previous disinfection was brought, several of the laundresses were attacked with the disease and died. The facts here stated were reported at the time in a local journal.[1]

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[1] Archives Italiennes de Biologie. Vol. 6, No. 1, 1884.

[2] Gazzetta Medica Italiana. Florence, 1854.

In 1880 Pacini competed for the grand prize of the Académie des Lincei pour la Biologie, presenting an essay in which he recited again the observations made by him on cholera, as well as his personal ideas in regard to the pathological processes involved in this infectious malady. The prize was not awarded to him because all the matter contained in his essay had appeared in publications prior to 1878, thus not complying with the conditions imposed upon competitors. In justification of their action in this matter, the sub-committee made a report from which the following is an extract: "As regards the nature of this organism (the *microbe cholérièμne*) and its diffusion in the human body, we know no more now than was made known to us by the first observations of Pacini in 1854. The examination of the well-preserved preparations made by Pacini, proves that the microbe is a schizomycete which assumes the forms of micro-bacteria and sphero-bacteria; but it has not been shown by means of cultures, and of experiments made with the products of these cultures, that this organism differs essentially from the septic ferment, either in the ultimate forms of its development or in its pathogenetic action. The studies made by Pacini from 1854 to 1867 render it probable that this parasite is reproduced principally in the intestinal mucous membrane."

A little later, in his lectures on pathological anatomy at Rome in 1881, Tommasi-Crudeli dwelt upon the discovery of Pacini and stated as his belief that the organism discovered by that observer not improbably bore a causal relation to cholera. And he said further that should this presumption prove true, it was not improbable that we should in time produce artificially a cholera vaccine by means of which the human organism might be protected from grave choleraic infection.[2]

In a little brochure intended chiefly for popular instruction,[3] Drs. Grassi and Ferrario thus treat Pacini's claims to priority in this discovery:

> "Forty years ago an illustrious Italian published a note in which he maintained that cholera was caused by a special parasite. The attempts to discover this parasite were prolonged, and many approached the truth without, however, ever arriving at it. We would mention here two Italians, Professors Cadet and Pacini, to whom is due the credit of having nearly simultaneously asserted that the seat of the disease is in the intestines, but the parasite described by Cadet is not found in cholera alone nor is it the specific cause of the disease, and the description of Pacini's microbe is not sufficiently clear. . . . The glory of having discovered the true and specific parasite of cholera belongs to Koch."

Writing on the same subject, Rusconi[4] also does not claim that Pacini actually discovered the comma-bacillus. But he thinks, that the researches of the German savant "have given a scientific foundation to many facts already announced by Pacini," more particularly concerning the lesions of the intestine, due, as Pacini maintained (though did not prove), to the presence of micro-organisms.

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[1] Osservatore Medico Siciliano. Palermo, 1867.

[2] Instituzioni di Anatomia Patologica, vol. i., p. 147, Rome, 1882.

[3] Per Difendersi dal Colera, Instituzioni Popolari, dei Dottori B. Grassi and G. Ferrario, Milano, 1884, p. 28.

[4] Il Colera Asiatico, Studio del Dottor Ulrico Rusconi, Milano, 1885.

On the other hand, D'Urso, in a little work also intended for popular instruction,[1] boldly claims for Pacini and other Italian investigators the honor of having been the first to assert that there were microbes in cholera.

We have given sufficient space to the writings of Pacini, to Tommasi Crudeli's argument in support of the Italian's priority claim, and the views of others, to show that Pacini undoubtedly found certain intestinal micro-parasites in cholera dejecta and in the walls of the bowel. But it is quite probable that Pacini did not discover the true comma-bacillus. Crudeli apparently overlooked the fact that Pacini described his microbes as "of granular or molecular form, being almost one-thousandth of a millimetre in size."[2] Oliveti, who quotes this description,[3] also very properly points out that the microscopes in 1854, when Pacini is said to have discovered his cholera parasite, were of such poor construction compared with the perfect instruments of to-day, that it is little wonder that he should not have recognized the exact form of the microbe, and should not have called it the comma-bacillus. But since he did not so describe it we have no certainty that he really saw the organism first accurately described by Koch.

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[1] Ettore d'Urso. Poche Parole sul Colera disette ai Padri di Famiglia, Bari, July, 1884.

[2] Filippo Pacini, Del Processo Morboso del Colera Asiatico. Firenze, 1880, p. 21.

[3] Brevi Cenni sul Colera Asiatico. Napoli, 1884, p. 6.

CHAPTER XX.

OTHER VIEWS ON THE NATURE OF CHOLERA.

HAVING given a succinct account of the leading theories concerning the etiology of cholera, including the parasitic dotcrines propounded before Koch's time, we will turn now to the published opinions of several other writers. Among these there are some whose large experience with the disease justly entitles them to be heard, even if their conclusions cannot be accepted. The views of a few eccentric authors will require no further refutation than their perusal will carry to the mind of the reader. The writings of Pettenkofer will be critically reviewed by Dr. Ely McClellan.

The Views of Lewis and Cunningham.—These observers carefully searched for characteristic organisms in cholera and cultivated those found. According to them, as already stated, the bacteria and vibrios contained in the stools present no characteristics by which they can be distinguished from those to be seen in the fæces of persons not suffering from cholera, or from those occurring in putrid fluids.

Lewis and Cunningham, however, believe in a localized generation of the disease, and point out that they observed a decided parallelism between cholera and malaria. They put the case as follows: "Does it not seem more reasonable to infer that the disease was generated at or near the place of its occurrence, in the same manner as outbursts of malarious fevers? There is nothing more remarkable in the production of an attack of cholera than in the production of an attack of ague; in some respects, indeed, the latter is the more remarkable of the two, seeing that, once acquired, the symptoms may recur at long periods after the original attack, and without subsequent exposure to the influences that originally produced it."

Again they say: "We would not for a moment have it supposed that we consider the two affections as mere gradations of the same disease; all that we desire to urge is that cholera has as good a claim as malarial diseases to a telluric origin. What the essential cause may be remains unknown in both cases; but the fact that the production of malaria is so generally under the control of improvements in the local conditions warrants us in looking confidently to similar results with regard to the cause of cholera also." In this connection a few words on what may be called

The Malarial Theory seem apropos. This hypothesis, like other erroneous views regarding the origin of cholera, has many superficial phenomena in its favor. It has always played a great part in the polemics of cholera, and notably so in the last great epidemic in the United States—that of 1873. Notwithstanding many positive declarations that it was true Asiatic cholera, a most respectable if not the largest number of physicians, both numerically and intellectually, while recognizing the disease to have been cholera of a fatal form, announced it as American cholera. It was not held to be endemic, but the epidemic was supposed to have had its origin in certain local malarial influences.

Another large class rejected entirely the cholera hypothesis, and pronounced the pestilence to have been pernicious bilious fever of an algid type, or a congestive malarial fever, etc., and when pressed by the facts took refuge in Dr. Flint's description of these disorders, or behind such terms as sporadic and septic cholera. (Peters.)

Dr. Peters admits that malaria or impure air, in all its forms, not excluding swamp malaria, may be great allies in the diffusion of cholera; but compound or mixed or civic bad air produced by all the causes which defile houses, grounds, cities, towns and villages is, he maintains, a still more positive adjunct.

Peters also writes:[1]

> "Drs. James Wynne and Buckler fastened this pure malarial hypothesis, for it does not reach the dignity of a theory, in their report of the outbreak in the Baltimore Almshouse in 1849, which was so enthusiastically adopted by my friend Dr. Bell, of Louisville, and of which I have said enough.
>
> "During our great civil war the United States had 2,335,942 men in the field, not counting the navy or the Confederate troops; there were 1,468,410 cases of malarial disease, with 46,310 deaths; 1,765,501 cases of intestinal disease, with 44,863 deaths, and 305 deaths in all from cholera morbus; but not one case of Asiatic cholera, because none was imported from 1861 to 1865, and there was none in Europe. In 1866, when these great armies were disbanded, cholera was imported and swept over the country.
>
> "If these blows are not heavy enough, study any map of the malarial districts in Italy, all of which remained free from cholera, while the non-malarial districts were attacked with it in 1884. The cities and provinces in Italy most heavily attacked by cholera last year were Turin, Cuneo, Genoa, Bergamo, Massa Carrara, Naples, Campobasso, etc."

Macnamara's Views.—This English authority has propounded a theory which is a modification of the one advanced by Snow, and also shows a leaning toward the opinions expressed by Farr and Pacini. Macnamara asserted that the specific organic matter causing the disease developed only after the dejections had commenced to undergo decomposition. Thus in the fresh state the intestinal discharges were harmless, but after a few days vibriones were formed, and then it was that the poison became active. This dangerous period was of short duration, and after standing a few more days the dejecta became again harmless. The matters passed from the bowels might, however, be dried, and still retain their potential infectious properties for an indefinite period, requiring only warmth and moisture to become once more active and virulent.

Macnamara also stated that the acids of the healthy stomach, and in fact all acids, were capable of destroying the action going on in the cholera matter, and so rendering it harmless. Certain degrees of temperature, both high and low, had a similar effect. Water was the most common medium by which cholera was disseminated among mankind.

He says further: "With the exception of the specific cholera-infecting matter, I entirely ignore all other causes, or combinations of causes, as capable of producing this disease. The circumstances under which people live may predispose them to its action; but neither air, water, nor any other material agency can induce an attack of cholera, though many of these may serve as media by which the infecting matter is conveyed into the intestines." Again in his "History of Asiatic Cholera"[1] he expresses himself as follows: "The disease can likewise be propagated by various articles of diet, such as milk, or in fact by anything swallowed which has been contaminated by the organic matter passed by cholera patients. In badly ventilated rooms the atmosphere may be so fully charged with the exhalations from the choleraic fumes that people employed in nursing the sick may become poisoned.

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[1] Manuscript notes furnished to the editor.—E. C. W.

"Fluids, and probably solids, exposed to air of this description absorb the organic matter, and may thus become the medium for transmitting the disease. In the same way persons engaged in carrying the bodies of those who have died from cholera for burial, or in washing their soiled linen, many contract the malady."

As evidence in favor of the direct communicability of cholera by means of water contaminated with cholera dejecta, Macnamara, among other things, cites his own experience in the following case:

A small quantity of a fresh rice-water stool was accidentally mixed with some four or five gallons of water, and the mixture exposed to the rays of a tropical sun for twelve hours. Early the following morning nineteen people each swallowed about an ounce of this contaminated water. They only partook of it once; but within thirty-six hours five of these nineteen persons were seized with cholera. The choleraic evacuation had not touched the soil. As it was passed, so it was swallowed. But it had been very largely diluted with impure water and exposed to heat and light for twelve hours.

Macnamara describes in detail a number of characteristic features of Asiatic cholera that are contained in the following propositions:

1. *The unequal and very partial distribution of cholera* is the first characteristic feature of the disease. This peculiarity is construed as a powerful argument against the acceptance of general epidemic or atmospherical influences to explain the origin of the disease.

"This localized action of cholera, whether occurring in countries, towns, villages, or however small the community may be, is, in fact, a characteristic which is more readily admitted than any of its other distinctive features."

Moreover this localized action must lead us to assume "some more tangible and specific cause than an imaginary something floating about in the air or carried by the winds from place to place."

Macnamara here alludes to a well-known experience, namely, that we may see "soldiers in a particular barrack or station struck down by cholera while regiments on either side of them entirely escape, precisely as though the one set of men had been exposed to a murderous fire on the battlefield, while the other had been kept as a reserve in camp, and out of range of the enemy's bullets."

The history of cholera furnishes a multiplicity of examples illustrating the limitation of the disease to particular spots and circumscribed areas. As in camps, so in towns, one side of a street may be attacked, the other completely escaping. Even in ships this singularly abrupt cessation or limitation has been observed. One part of a vessel may suffer severely; another at the same time not at all.

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[1] A History of Asiatic Cholera. By C. Macnamara, F. C. U. London, 1876.

2. *The inhabitants of certain districts are especially liable to be visited by cholera, and these localities have features in common with one another, differing from other places which have usually escaped its influence.*

In a general way it has been found that cholera has been most destructive in large seaport towns, and the majority of these are built on low-lying, alluvial soils, at the mouths of rivers; frequently they are densely populated. Speaking broadly, the lower the level the greater the mortality from cholera. There are of course exceptions to this rule.

The prevalence of cholera in low-lying towns was noticed by Jameson as far back as 1820. The medical board of his day explained the fact by drawing attention to the likelihood of such towns and places being inhabited by an overcrowded and poor population, living under the worst hygienic conditions, breathing impure air, drinking impure water, and consuming impure food. Macnamara, however, very properly points out that the disease has been very virulent in places built on high elevations, or even on lofty mountain ranges. He rightly believes that the imperfect state of health of the poor influences the apparent violence of an outbreak much more than the actual locality of their dwelling-houses. It may be borne in mind, however, that it is precisely the lower classes who commonly have their houses about the lowest levels of a town. The defective water supply of their houses or huts may also be noticed in this connection, as favoring the susceptibiliy to cholera.

3. *It by no means, even in the majority of instances, attacks the inhabitants of the most insalubrious localities, even in our larger towns.* There seems to be a contradiction between this and the foregoing proposition. But it is apparent rather than real. Simon has demonstrated that while in London many habitual seats of fever were visited by the cholera, some of the worst fever nests in the whole metropolis were unaffected by it. But this only proves, what hardly requires to be repeated, namely that even under the worst hygienic conditonis, the disease cannot arise *de novo.* This is more clearly brought out in the following statement:

4. *No amount of overcrowding, no special condition of the soil, nor any circumstance with which we are acquainted, has ever been known to originate Asiatic cholera de novo among men removed from its endemic influence. or unless the disease has been epidemic at the time beyond the confines of India.*

The history of cholera teems with examples illustrating the truth of this proposition. And especially we, the inhabitants of America, have reason to believe implicitly in this highly important characteristic of Asiatic cholera.

The crews of vessels among whom the disease has apparently originated many days out at sea, have invariably been shown to have had intercourse with some country affected with the disease.

5. *The intensity of cholera varies during its continuance in a country or a large town, so that it has periods of little and great activity, in fact, usually well-marked periods of increase, culmination, and decline.*

This characteristic feature of Asiatic cholera is indicated by the frequent use of the terms "outburst," "onslaught," "outbreak," "ravages," etc., in connection with the disease, which all denote the appalling rapidity with which a whole community may be stricken down with it. As a rule, the first outbreak of cholera is the most malignant. The gradual declension which follows may, however, be more or less frequently interrupted by manifestations of renewed activity and virulence on the part of the malady. In the Paris epidemic of 1831, of the first 98 cases admitted into a certain hospital, as many as 96 died. And similar instances of the early malignancy of cholera abound in the history of the disease throughout all countries. A peculiarity like this can only be rationally accounted for by the action of a specific organized cholera-virus.

6. *After having been a certain time epidemic in a locality, it entirely disappears, unless in its endemic area.*

Macnamara observes that we know no physical laws which can account for the limitation of endemic cholera to India, nor why the disease gradually dies out after a few years of life and vigor in any other country. But this in no way detracts from the certainty or value of the facts. Outside of India, it must always be rekindled by a fresh importation. Like certain tropical plants, it appears incapable of a long-continued existence beyond the region from which it originally sprang; it may, however, live and bear fruit even in the cold of a European winter, if fostered in carefully-warmed conservatories, as, for instance, in the overheated houses of the Russians. Unless cared for in this way, it becomes dormant in the cold of a European winter, to sprout out again in the heat of summer, but with less vigor than in the year of its primary invasion. As regards this remarkable feature of cholera, it may not be amiss to point out here that Koch's comma-bacilli are minute tropical plants, which, unless artificially cultivated, show a decided tendency to succumb to unfavorable surroundings. They flourish only on suitable soil; when this is not found they are doomed to speedy death.

7. *Every outbreak of the disease beyond the confines of British India may be traced back to Hindostan, through a continuous chain of human beings affected with the disease, or through articles stained with their dejecta.*

Cholera has never been observed to travel faster than man travels. In America we can be particularly positive about the truth contained in this statement. For in no single instance did the disease break out among us before the arrival of one or several vessels from infected foreign ports. It never started inland, being always first observed in some seaport town. For full particulars substantiating this assertion the reader is referred to the chapters on the history of the disease.

8. *The more explicit the examination, the clearer the fact appears, that the disease, in the majority of cases, spreads from one human being to another by means of the cholera fomes finding its way into the drinking water, and thus into the intestines of other people.*

So long as Macnamara admits that this statement does not imply that drinking water contaminated with choleraic fomites is the only and exclusive mode of dissemination, we may accept his opinion without scruple. The doctrine promulgated by Snow in connection with the epidemic of 1849 will be seen to cover this characteristic feature of cholera.

Macnamara further insists that, "so surely as water contaminated with choleraic dejecta is capable of reproducing the disease, when consumed during the vibrionic stage of decomposition, so certainly it may be drunk with impunity after this stage is over, and when various forms of ciliated infusoria have replaced the vibriones." By which Macnamara does not, however, mean to imply that the vibriones have any influence in inducing cholera. Koch found his comma-bacilli to perish in the presence of numerous bacteria of later development—a circumstance that may account for the harmlessness of decomposed dejections.

The Views of Pettenkofer.[1]—During the past thirty-five years Pettenkofer has given to the world an extended array of cholera works. So frequently and so dogmatically has he written upon this disease, that it would seem as if he considered it his own preëmption: Pettenkofer's disease.

This latter end of the nineteenth century is unqualifiedly progressive, and Pettenkofer is undoubtedly the most progressive of cholera philosophers. In 1854 he adopted in an enthusiastic manner the theory of Von Gietl as to the significance of diarrhœa in cholera, but he soon found that he was untrue to himself in countenancing a too evident proposition, and he thereupon abandoned it for his more elaborate "ground-water" and local origin hypothesis. Upon this he has erected a most perplexing superstructure, which he surrounds with a confused glamor of numberless, unmeaning, and unnecessarily tedious details. This he calls scientific argument.

At the Cholera Conference of 1867, he remarked: "I have no doubt whatever that cholera is propagated by means of movements of men and things," but perceiving that for once he had made himself quite intelligible, he added:

> "We must start with this principle, that a given locality is the focus of cholera, from which the germ of the disease is propagated by man. It is true, however, that man, coming from the infected locality, transmits this germ; still it is not his body, strictly speaking, which is the direct agent of transmission. Recent experiences in Germany, and particularly in Bavaria, at Munich, Heilbronn, and Spires, do not establish a correlation between the recognition of the first symptoms of cholera in a place and the arrival of patients from an infected locality, so it is still the locality itself which is the true focus of the germ."

Is it any wonder that the illustrious Professor Parkes arrived at the conclusion that "Pettenkofer's views are rather difficult to understand," and "that they seem rather wanting in clearness of expression."[2]

The theory advanced by Pettenkofer prior to 1865 was that there was necessary for the production of cholera—1. A layer of soil permeable to water and air, extending down to the line of the subsoil water. 2. The receding of the line of the subsoil water from a previously attained *unusual* height. 3. The presence of organic and especially excrementitious matter in the receptive layer of soil. 4. The specific cause of the disease which is carried chiefly in the intestinal discharges of cholera patients, and possibly of healthy individuals also, who may come from infected places. 5. An individual predisposition to the disease. He also maintained, 6. That the specific cause of cholera becomes active through changes occurring in the soil, and not within the human organism.

In 1867, in answer to Hirsch, he said:

> "I by no means deny the transmissibility of cholera by man coming from an infected place. I consider man alone as the specific cause outside of the influence of the infected locality; moreover, I consider him the propagator of cholera when he comes from a place where the germ of the disease already exists."

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[1] The writings of Pettenkofer have been so numerous, and have withal commanded so much attention, that the editor has deemed it permissible to allow rather more space to their consideration than their intrinsic merit really demands. Dr. McClellan has kindly consented to give this part of the work his special attention. By supplementing the editor's material, as well as by various comments upon Pettenkofer's claims and assertions, Dr. McClellan clearly shows that the Bavarian writer's dogmas are quite untenable.

[2] Army Med. Dept. Reports of 1873. London, 1875, p. 198.

But he asserted that there must be a local subsoil disposition to cholera, as evinced by the immunity enjoyed by many places; but there was also in places in which the disease was prevalent, a varying rise and fall in the degree of local susceptibility. The cause of this variation, he asserted, is to be found not in the season of the year or in the condition of the atmosphere. It resides in the soil and is due to variations in the level of the subsoil water, that is, in the varying degree of saturation of the ground. It was still undetermined, he thought, whether a certain condition of the soil was necessary for the development of the cholera germ, transmitted to it through commerce or human intercourse, or whether the germ became active independently of this condition, and that an individual predisposition was occasioned by telluric influences.

In 1871 Pettenkofer again strenuously denied that cholera was a contagious or infectious disease. He insisted that the cause lay in a local soil disposition. He maintained that the spread of cholera in India itself could be explained much better by his subsoil-water theory than by the atmospheric theory of Bryden. He also claimed that by his theory the immunity which certain places *always enjoyed*, and which others only *occasionally enjoyed*, could be satisfactorily explained. Again, having learned that cholera epidemics of virulent type had occurred on ships in mid-ocean, he asserted that no one could get cholera on shipboard except those individuals who had imbibed the germs of the disease on shore, or who had received into their system some subsoil water, or malaria; that there was no spread of the disease from person to person on shipboard, no contamination of fabrics with cholera discharges, and that no infection of food or drink could occur; that so soon as all who had imbibed the disease on land either died or got well, the ships were pure—the disease having died out, as it had no earth, soil, or subsoil water to breed in.

Pettenkofer has evidently had but little to do with ships—what a pity he did not know that there was bilge-water on board ships. Had he known that fact what a magnificent theory he might have built up.

In 1877 Pettenkofer was in great danger of becoming finally intrenched in Bengal. One almost thought that he had fully joined hands with the Indian sanitary commissioners and was at last convinced "that cholera appears to be due to certain conditions of air and soil, or of both, as yet little understood."

The Bavarian savant, however, escaped, for in 1885 he is, if possible, more emphatic than ever in support of his local soil views, and more virulent in defending them against the adverse criticism they have so liberally received.[1]

The official report as to the variations of the "ground water," and to the general water supply of the city of Munich in 1873, was *most unfortunate* for Pettenkofer's theory.

> "In January, 1873, the ground water was relatively deep; it rose in March, and on the 30th of June was higher than it had been for a long time. At that time the cholera commenced; the ground water fell a little in July, but rose again in August, so that on the 27th of August it stood at its highest point; but while it was thus rising the cholera was at its greatest intensity; from the 27th of August, the ground water fell continuously until November, and during all this time cholera declined, while, according to Pettenkofer's theory, it should have increased; on the 19th of November the ground water began to rise, and exactly at this time cholera

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[1] One critic went so far as to prove the introduction of cholera into the Bavarian prison at Laufen from the very data furnished to prove that it *had not been introduced* but had originated from subsoil influences.

again increased and reached a second acme. In January the ground water fell. Cholera was less than in December, but still was more than in October and November." Upon this evidence Dr. Parkes remarked: "In fact, not to go into details, it seems certain that no connection could be maintained between the changes in the ground water and the cholera cases, and Pettenkofer's hypothesis has thus received a severe and perhaps fatal blow in the very place where the evidence was supposed to be the most favorable to it."

His most recent writings published originally in *Nord und Süd* (then reproduced in pamphlet form,[1] also translated in full in the London Lancet,[2] and republished in America),[3] indicate, on comparison with his former assertions, that he now endeavors to reconcile his local subsoil water theory with the results of recent inquiry into the etiology of the disease.

No attempt will be made to follow Pettenkofer through all the windings of this last presentation of his theory. Indeed space would not be taken for it at all, were it not that such theories are mischievous to human life and should not pass unchallenged. The component parts of his theory as it now stands have been abstracted from his "scientific argument," and will be strung together.

Pettenkofer now writes:

> "Cholera is an infectious disease. By infectious diseases are meant those diseases which are caused by the reception from without of specific infective material into healthy bodies, which material acts like a poison. Infective material differs essentially from lifeless chemical poison in being composed of the smallest possible units of living matter which when taken into healthy bodies rapidly increase and multiply under certain conditions and by their life-growth disturb the health of the body. These germs of disease belong to the smallest units of life, to the schizomycetes, which lie on the border-land of the invisible, and which, according to their form, are known as cocci, bacteria, bacilli, vibriones, and spirilla, and thirty millions of which, according to Naegeli, hardly weigh one milligramme! . . . Cholera always requires for its propagation favorable stations on land, and, as a rule, if the course of epidemics be traced, a gradual extension in successive years is found to take place in fixed directions. . . . Not only does the physical nature but also the chemical constitution of the soil have an influence on the occurrence of cholera—to wit, the presence of organic matter and water. The influence of the soil on the development of infectious diseases can only be understood by a study of the organic processes which take place in it. The processes are eventually dependent on the action of the lowest organisms, which require for their growth a certain temperature, so much water, air, and food-stuffs. In order to explain the occurrence of cholera on such varied soils as those composed of granite, sand-chalk, and shell-chalk, we must suppose that the soil contains in its interstices much organic matter and water. . . . The germs of putrefaction and fermentation abound in the free atmosphere, but they only grow and multiply where they find suitable food. The refuse from houses, dissolved or suspended in water, forms an excellent nutritive material for the lowest organisms which are so harmful to us. . . It is clear, in my opinion, that the soil and the moisture of the soil play a principal part. The dampness of the soil is, under certain conditions, clearly related to the subsoil-water, "grundwasser." Epidemics of cholera abound during the time that the "grundwasser" is falling, when the earth is comparatively dry. By "grundwasser" is to be understood that condition of dampness of a porous soil when all the pores are filled with water. If water and air together fill up the interstices, then the soil is called simply damp. I have so long and so often spoken on the influence of the rise and fall of the ground-water on the frequency of typhoid fever and cholera, that I imagine a great many scientists credit me with the view that subsoil-water is highly harmful. But such is not the case. The subsoil-water is merely an indication of what is going on, and has no more to do with the actual processes than a dial and the hands have in the going of a clock. The fall of the ground-water

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[1] Die Cholera, von Max Von Pettenkofer. Berlin and Breslau, 1884.

[2] Cholera, by Max Von Pettenkofer, Nov. 1, to Dec. 20, 1884.

[3] Popular Science Monthly, February, March and April, 1885.

by pumping away, or the rise of ground-water by the damming of a stream, has not the least effect on typhoid fever or cholera in the neighborhood. The observation of the level of the surface of the water in springs as an indication of the state of the subsoil-water is of no value from an etiological point of view, unless the spring be independent of the nearest water-course, and unless at the time of the observation the real state of the spring is a true reflex of the condition of the subsoil-water in its neighborhood. . . . When an epidemic of cholera occurs in winter, then a relatively low state of the ground-water is found to prevail."

But at Munich in 1873 on the 19th of November the ground water began to rise, and exactly at this time cholera again increased and reached a second acme.

It does seem as if it would be well for Pettenkofer not so persistently to ignore the work of real investigators. One can scarcely believe that he would have written the last sentence quoted had he been familiar with the fact that a very severe epidemic of cholera occurred in Russia during the winter of 1853–54 which could only partially be accounted for by the habits of the Russian peasants, the construction of their houses, the faulty heating apparatus they employ, until Doctor Routh pointed out that in the Russian settlements everything is thrown out around the dwellings, and that owing to the intense cold and the great expense of transporting drinking water, the Russian peasants are in the habit of drinking the water of melted snow; that investigation showed that the snow used for that purpose was frequently that on which cholera stools had been thrown, and that by this impure drinking water the epidemic was prolonged.

The ground water during this epidemic was most certainly in "a relatively low state;" it was most certainly in a perfectly frozen state, and it must be very clear, that neither the soil nor its mixture played any principal part in that epidemic.

Again the peculiar method of reasoning adopted by Pettenkofer is shown in connection with observations he made in the Munich epidemics of 1836, 1854 and 1873, as well as by certain alleged facts which he presents regarding the city of Augsburg visitation of 1854. Because Munich and Augsburg are very much alike in situation and meteorological factors; because they are in a direct line not far apart; because differences in amount of rainfall occur; because Augsburg had an epidemic of cholera in 1854 and none in 1836 or 1873, "*when only a few isolated cases occurred;*" because Augsburg in place and time and individual disposition is susceptible of a cholera epidemic; because Augsburg once lost three per cent. of her population from cholera, while Munich lost in the same epidemic (1854) but two and a half per cent. of her population; because in 1836 Augsburg remained free from cholera, while Munich was infested for six months; and because no doubt exists that cases of cholera passed, without isolation and disinfection, from Munich to Augsburg; because of all the foregoing, it is *proven that cholera is a miasmatic disease and may be wholly independent of human intercourse.*

The writer (Dr. McClellan) has long been of opinion that Pettenkofer did not in reality understand or comprehend the views of those whom he calls contagionists.

Read what he himself says:

"I shall now leave the arguments for the localists, and pass on to consider the circumstances which are favorable to the views of the contagonists. That an epidemic of cholera does not permanently last in one place, but after a longer or shorter time ceases, *is explained by the contagionists as due to the saturation of the population, whereby each individual acquires a protective influence against cholera similar to that acquired after vaccination as against small-pox, and* *other like instances.* This hypothesis does not explain why an epidemic is sometimes rapid and sometimes slow in its course, why it is sometimes vast in its ravages and at other times slight in its effects, while the condition of mankind remains practically the same. With as much reason might the localists assert that the germs of cholera find at different times the local conditions to be favorable or unfavorable, with the natural consequences of growth or death."

The italics are supplied for emphasis. Not content with forming a theory for the guidance of himself and followers, he manufactures one for those whom he considers his opponents and whom he stigmatizes as "contagionists." No such theory has ever been advanced by any one but Pettenkofer. He really should study up the "theory" (?) of well-instructed epidemiologists before he writes again, when he will find that nothing of the kind he has stated has ever been claimed; but, *even if he will not do so, it is of no further importance.*

Chapman's Neurotic Theory and Similar Views.—Dr. John Chapman is the indefatigable champion of a rather ingenious theory, ascribing cholera to a primary disturbance of the nerve-centers. Where so many distractingly confusing theories have been propounded, we have scarcely the right to completely ignore decided views, even when they seem on reflection irreconcilable with fact and extravagant. We may, therefore, be permitted to briefly indicate the essential points in Chapman's theory, as well as the nature of his pretensions to have it recognized as alone capable of explaining the true character of cholera.

Having repeatedly claimed for this disease, and indeed all diarrhœal disorders, a purely neurotic origin, Chapman quite recently again comes to the front with a loud flourish of self-assertion. In the Westminster Review, for October, 1884, he publishes an elaborate paper on "The Non-contagiousness, Causation, and Scientific Treatment of Cholera," in which he substantially repeats his former views and adduces further alleged evidence in support of them.

Chapman believes that his doctrine alone affords a complete and consistent explanation of all the seemingly mysterious phenomena of the disease. It may be thus expressed: All the symptoms of cholera are due to simultaneous and abnormal superabundance of blood in, and excessively preternatural activity of, both the spinal cord and the sympathetic nervous centers.

He states that

> "During the last half-century many students of cholera have ascribed it to disorder of the nervous system. In 1831, Dr. G. H. Bell, in his work, 'Cholera Asphyxia,' endeavored to prove that the disease is due to a morbid state of the Sympathetic. Several other Anglo-Indian physicians, impressed especially by the spasmodic phenomena of the disease, ascribed it to disorder of the nervous system. In 1832 a French physician, Dr. L. Auzoux, published the doctrine 'that cholera is to the great Sympathetic what epilepsy is to the brain.' Dr. Davey, in his work on the 'Ganglionic Nervous System,' published in 1858, claims to have shown that cholera is due to a morbid state of that system. The eminent English physician, Sir William Gull, refers the symptoms of the disease to 'an early and severe depression of the ganglionic nervous centers;' Dr. Copland, in his 'Medical Dictionary,' expresses a like opinion; and Dr. Goodeve, one of the most recent of the English authoritative writers on cholera, says that the state of the lungs and intestines implies that the nervous system is under a morbid influence. But though the authorities in favor of the hypothesis that, to a large extent at least, cholera is a disorder of the nervous system, are numerous and weighty, all of them ascribe the disorder exclusively to the action of the Sympathetic: the *rôle* of the cerebro-spinal system is wholly ignored, and while several of these pathologists are of opinion that the sympathetic nervous system is profoundly depressed or exhausted, no one of them explains in what consist the several links in the

chain of causation between the alleged disorder of this nervous system and the manifold symptoms of the disease."

He then takes up seriatim the different symptoms of cholera and endeavors to account for them in the light his theory. This part of his argumentation is strained, far-fetched, and thoroughly unsatisfactory. He ignores the actual primary lesions of cholera, and substitutes therefor his suppositious neurotic disturbance. The various structural alterations found in cholera are to his mind merely secondary disease-processes.

Having shown to his own satisfaction that all the symptoms of cholera are produced by a preternatural, tumultuous energy and activity of the nervous system—both cerebro-spinal and sympathetic; and that, though extremely numerous and various, they are completely accounted for by the operation of one and the same immediate cause, he disposes at one stroke of all other theories, including that of Koch. For, says he,

> "While the hypothesis now briefly expounded does not exclude the possibility of the existence of a cholera poison, germ, or microbe, it is self-sufficing, and this fact renders it extremely improbable either that any such poison, germ, or microbe is causative of cholera, or that the disease is in any sense more infectious or contagious than is sunstroke or epilepsy."

Chapman's treatment is by the spinal ice-bag. He states that it must be put exactly along the center of the spine, and it will do harm if not kept there. By this convenient doctrine, he can readily account for any want of success in treatment by his method. Chapman makes the astonishing claim, that his method is approved alike by medical science and common sense, that it is thoroughly practicable, that it is sanctioned by the experience of every physician who has adopted it, and has been proved to be successful to a degree surpassing that of every other kind of treatment which has hitherto been tried.

Such statements are certainly too much exaggerated to deserve more than this passing mention. Nor is it surprising to find their author entertaining the further equally false notion that the summer diarrhœa of Europe, the cholera infantum of the United States of America, the diarrhœa premonitory of cholera, cholera *nostras*, and Asiatic cholera are all mere varieties or grades of intensity of one and the same disease, and that they are all alike due to the same *proximate* cause, and are controllable in one and the same way, namely by the spinal ice-bag.

That associated with cholera there are grave nerve-disturbances is disputed by no one. And it would be the part of ignorance to deny their great significance and importance. Yet they are secondary manifestations, which follow primary intestinal disturbances as clearly as do all the other symptoms and phenomena that characterize an attack of cholera. It is rendered probable by the results of recent investigation that chemical bodies allied to the ptomaines enter the circulation, and acting with great energy upon the nerve-structures produce those decided perturbations of their functions witnessed during an attack.

But although we must reject the theory of the neurotic origin of cholera, it may nevertheless be remembered that in a somewhat modified form, it has other supporters beside Chapman and the authors mentioned by him.

Thus Briquet and Mignot, in 1865, announced before the Paris Academy of Medicine that cholera was due to the action of a miasmatic poison attacking the cerebro-spinal system and producing a "veritable hyposthenization."

Again an eminent French writer, Laveran, accepts almost unchanged the views of Briquet and Mignot. He says that when enough of the cholera poison has found its way into the system, it attacks directly the cerebro-spinal system, and only through this intermediate nerve-action the cardiac, pulmonary and intestinal symptoms are developed; even the hyperæmia of the intestinal mucous membrane observed in cholera is, according to him, caused by vaso-motor paralysis.

In our own country Dr. Fred. Humbert,[1] in a recent article on Asiatic cholera writes as follows: "And now when we collect all the symptoms into one picture and add our own experience to form a diagnosis, we come to the conclusion that we have here a shock of the nervous system—prominently the sympathetic."

Another American writer, Dr. Raymond Rogers,[2] in an article on "Cholera: Its disastrous past and its more hopeful future," also maintains that the disease is essentially a neurosis. He says:

> "The hope for better results clearly depends upon our breaking loose from old traditions, old theories, old systems, so as to be able to read the disease in the pure, simple light of its actual symptoms, and its well-known cadaveric autopsies. Then will the essential character of the disease be discovered, and at the same time its rational and successful treatment."

Whereupon he immediately "breaks loose" in the following words:

> "It is essential to the healthy physiological action of the brain, that it be supplied with currents of blood normal in constitution and in full measure. The sudden disturbance in its equilibrium, in either of these respects, is capable of producing sudden and sometimes alarming or fatal effects. The pinched visage, sunken eyeballs, lusterless eyes, burning thirst, hoarse voice, washerwoman's hands, suppressed urine, cold extremities, and the voiceless yet speaking cadaver, all tell the story of emptied blood-vessels and a depleted brain. These conditions necessitate a speedy re-supply for the brain and heart. This can be accomplished only through the instrumentality of gravitation—*by position*. Let it therefore not be forgotten that the treatment of cholera resolves itself, in a measure, into a simple problem in mechanics—in hydraulics—upon the principle that water (or blood) tends to run down hill. This philosophy is emphasized in the fact that the loss of blood which, in the upright position, would quickly produce syncope or death, would scarcely be heeded in the horizontal position. *Position* thus becomes the fundamental consideration in the treatment of this disease—horizontal in mild cases, or inclined, with the head lowest, in grave attacks. We have reason to suppose that position alone would save a large proportion of the cases which otherwise would prove fatal. In severe attacks the inclination of the body should be strictly maintained until reaction becomes established."

Comment upon this remarkable extravaganza does not appear to be called for.

In striking contrast with these alarmingly transcendental nerve-theories are

Lebert's Views.—This German writer of large experience accepts a cholera germ as the single ultimate cause of the disease. His account of the etiology of cholera is written, as it were, with prophetic foresight of Koch's discovery. He argues from the facts belonging to the natural history of cholera, and thus reaches conclusions that are in almost complete harmony with the much later views of the German mycologist. He says distinctly:

> "In explaining the development and diffusion of infecting parasitic germs, I have adopted a view which seems to me not only to be in harmony with the facts of natural history, but also calculated on the one hand to refute every exclusive

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[1] Journal of the American Medical Association, February 28, 1885.

[2] Ibid., October, 18, 1884.

theory, and to show, on the other, that we are not justified in skeptically rejecting facts simply because they are not constant."

Lebert calls his theory the "mycetic" one, for it ascribes the origin and development of cholera to parasites of the lowest form and smallest size. He believes in a minute, specific, and peculiar Indian parasite, that develops its action, wherever it is carried, provided it finds favorable conditions for prolific reproduction. From what is known of the life of these lowest organisms, it is readily understood that the air cannot be the chief agent in the dissemination of cholera. When the germs are fixed to some lifeless substance their activity may be increased by contact with fluids. The frequent infection of washerwomen handling soiled linen is explained by Lebert in this way.

The important rôle played by the water impregnating the soil is due to the fact that if it be rich in nutritious matter for bacteria, if acts as a breeding-place for the infectious parasites. In drinking water cholera finds a frequent and potent medium of dissemination, but drinking water alone cannot be considered as an exclusive or even necessary means of conveyance.

In other words, cholera recognizes no one element of dissemination,

"not even that most frequently injurious, as the sole sovereign and dominant factor in its etiology. Among the reasons why the disease does not fully develop under apparently favorable conditions, we may notice here again the fact that the germs may reach even an exuberant growth in the water of the soil and then be destroyed by otherwise innocent bacteria of putrefaction and fermentation before they have come into thorough contact with the human organism. A specific germ, a favorable medium of development, sufficient contact with the human organism, only slight and temporary development of the protomycetes destructive of the cholera germs, these are the fundamental conditions for the development and diffusion of cholera to any great extent, and every perturbation, every solution of continuity in the chain of these factors of development may prevent or lessen its destructive action.

"The natural history of the protomycetes teaches us again that the exuberant growth of the cholera germs may be brought to an end, even when at the height of their destructive activity, by the development of other harmless parasites."

It has been shown that raftsmen and boatmen, with their families, may infect various landing places. Dissemination of the disease on a grander scale occurs in the same way by sea voyages from one part of the earth to another.

Yet the precise way in whicn the disease is conveyed may remain quite obscure in particular instances.

"For the germs may be disseminated and the disease spread by subjects of choleraic diarrhœa who have subsequently recovered without further symptoms, or by slightly soiled linen and other effects of cholera patients. We know how invisibly and variously bacteria usually spread themselves, and we know that it is not possible for the most carefully organized sanitary police to subject every cholera germ to inspection."

He doubts the influence of dead bodies in communicating the disease, believing that "putrefaction rather diminishes the capacity for infection, and that the bacteria of decomposition destroy the germs of cholera." It will be seen presently how completely these views accord with Koch's doctrine.

Lebert believes that it is possible for the cholera germs to be disseminated by the air. A strong proof of this possibility he finds in the other wise inexplicable

"occurrence of a peculiar diarrhœa in large cities so soon as cholera has taken root, as well as that other fact that during the prevalence of cholera diseases of the most different kinds may show some of the unmistakable signs of cholera. The relations between cholera and other epidemics do not favor the belief that the one can exclude the other, any more than that they are intimately connected with one another as regards their origin."

But atmospheric dissemination is insignificant when compared with the far more frequent conveyance by infected water. He sums up his views on the subject in the following manner:

> "The truth is, nothing acts exclusively in the development of cholera. The only indispensable factor is the cholera germ; this acts in every case, from the lightest to the most severe, at every period, in every epidemic, in every land of the earth, and yet its action, too, varies in extreme degree. In many cases it causes but a temporary diarrhœa or a light cholerine, while in other cases it may be fatal in a few hours, the difference depending probably on the numbers in which it has entered, and on the favorable or unfavorable conditions of development it encounters in different individuals. Since, then, all other etiological conditions must first act through this fundamental cause, and since this germ is diffused chiefly by fluids, but may also be spread by the air, by the clothing and bedding, by various emanations and infiltrations, it may be readily understood that there is as much irregularity in the nature of the vehicle of the germ as in the mode of penetration of the vehicle into the recesses of the organism."

Having acquainted the reader with the etiological opinions of several writers, most of whom are foreigners, we may now turn our attention to a few representative

American Views.—The official report on the cholera epidemic of 1873 in the United States,[1] is one of the most instructive works on the disease ever issued in any country. Dr. John M. Woodworth offers a series of propositions "condensed from the vast mass of cumulative evidence which has been laboriously collected by a multitude of cholera-students in both hemispheres." As these propositions are intended to bear solely upon the question of the exclusion of the disease from this country, they are here reproduced.

"1. Malignant cholera is caused by the access of a specific organic poison to the alimentary canal, which poison is developed spontaneously only in certain parts of India (Hindostan).

"2. This poison is contained primarily, so far as the world outside of Hindostan is concerned, in the ejections—vomit, stools and urine—of a person already infected with the disease.

"3. To set up anew the action of the poison, a certain period of incubation with the presence of alkaline moisture is required, which period is completed within one to three days; a temperature favoring decomposition and moisture or fluid of decided alkaline reaction hastening the process, the reverse retarding.

"4. Favorable conditions for the growth of the poison are found in ordinary potable water containing nitrogenous organic impurities, alkaline carbonates, etc.; in decomposing animal and vegetable matter possessing an alkaline reaction; in the alkaline contents of the intestinal portion of the alimentary canal.

"5. The period of morbific activity of the poison—which lasts, under favorable conditions, about three days for a given crop—is characterized by the presence of bacteria, which appear at the end of the period of incubation and disappear at the end of the period of morbific activity. That is to say, a cholera ejection, or material containing such, is harmless both before the appearance and after the disappearance of bacteria, but is actively poisonous during their presence.

"6. The morbific properties of the poison may be preserved in posse for an indefinite period in cholera ejections dried during the period of incubation, or of infection-matter dried during the period of activity.

"7. The dried particles of cholera-poison may be carried (in clothing, bedding, etc.) to any distance; and when liberated may find their way direct to the alimentary canal through the medium of the air—by entering the mouth and nose and being swallowed with the saliva—or, less directly, through the medium of water or food in which they have lodged.

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[1] Washington, 1875.

"8. The poison is destroyed naturally either by the process of growth or by contact with acids: (1) those contained in water or soil; (2) acid gases in the atmosphere; (3) the acid secretion of the stomach.

"9. It may also be destroyed artificially (1) by treating the cholera-ejections, or material containing them, with acids; (2) by such acid (gaseous) treatment of contaminated atmosphere; (3) by establishing an acid diathesis of the system in one who has received the poison."

In the same volume Dr. Ely McClellan formulates the following propositions touching the causes of epidemic cholera.

"1. Asiatic cholera is an infectious disease resulting from an organic poison, which, gaining entrance into the alimentary canal, acts primarily upon and destroys the intestinal epithelium.

"2. The active agents in the distribution of the cholera poison are the dejections of persons suffering from the disease in any of its stages. In these dejections there exists an organic matter which, at a certain stage of decomposition, is capable of reproducing the disease in the human organism to which it has gained access.

"3. Cholera dejecta coming in contact with and drying upon any object, such as articles of clothing, bedding and furniture, will retain indefinitely their power of infection. In this manner a sure transmissibility of the cholera infection is effected, and a distinct outbreak of the disease may occur by such means at great distances from the seat of original infection.

"4. The specific poison which produces the disease known as cholera originates alone in India, and by virtue of its transmissibility through the persons of infected individuals or in the meshes of infected fabrics, the disease is carried into all quarters of the world. Cholera has never yet appeared in the western hemisphere until after its route of pestilential march has been commenced in the eastern world. Its epidemic appearance upon the North American continent has invariably been preceded by the arrival of vessels infected with cholera-sick or laden with emigrants and their property from infected districts.

"5. The respiratory and digestive organs are the avenues through which individual infection is accomplished. Through the atmosphere of infected localities, cholera is frequently communicated to individuals. Water may become contaminated with the specific poison of cholera, from the atmosphere, from surface-washings, from neglected sewers, cesspools or privies. The use of water so infected will induce an outbreak of the disease.

"6. The virulence of a cholera demonstration, the contagion having been introduced into a community, is influenced by the hygienic condition of the population, and not by any geological formation upon which they may reside.

"7. One attack of cholera imparts to the individual no immunity from the disease in the future, but the contrary seems to be established."

Dr. Hartshorne in 1866,[1] and again in 1881,[2] announced the following belief:

"That the cause of cholera is a (yet undiscovered) protozoon, or primal organism, of extreme individual minuteness, which, on entering the human body, affects it as an organic poison. That the varying quantity or number of these organisms may in different cases account (along with individual predispositions and exposures) for the unequal violence of different epidemics, as in the case of trichiniasis. Choleraic diarrhœa or cholerine, so frequent before as well as during and after the prevalence of cholera, may in some instances, at least, be explained by the action upon the alimentary canal only of a minimum quantity of the cause. The dreadful fatality of some Indian seasons is, on the same view, referred to an extreme accumulation of it."

Dr. Loomis[3] considers epidemic cholera an acute, infectious, non-contagious disease, probably of miasmatic origin. As soon as the cholera discharges undergo decomposition the specific infection of the disease is developed, and may be conveyed from one locality to another by the wind, by rivers, and in clothing. An individual traveling rapidly from one place to another becomes the carrier of the germ which is to develop the infection in those localities in which the conditions favor its reproduction.

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[1] Cholera: Facts and Conclusions as to its Nature, Prevention and Treatment. By Henry Hartshorne, A.M., M.D. Philadelphia, 1866.

[2] Essentials of the Principles and Practice of Medicine. Philadelphia, 1881.

[3] A Text-Book of Practical Medicine. New York: W. Wood & Co., 1884. Second edition, p. 663.

Dr. Austin Flint, sr.,[1] in 1881 said:

> "If the germ-theory be adopted as affording the most rational explanation of the causation of other infectious diseases, this disease (cholera) certainly comes within the range of its application. Adopting this theory, the disease requires for its production a specific germ or organism. Adopting the theory of indirect communicability, as just stated, germs are contained in choleraic excreta, but they require development under favorable conditions without the body in order to acquire infective power. . . . When the cholera-germ has undergone the requisite development, it may be transported in the atmosphere or carried from place to place attached to clothing, merchandise, etc. It is also intelligible that undeveloped germs may in like manner be transported, and find, in situations more or less distant from the places in which they are produced, the conditions favorable for their development."

More recently Flint is inclined to accept Koch's doctrine.[2]

Dr. Bartholow[3] says that "the facts thus far accumulated render it highly probable that cholera is propagated by a minute organism." And "although the cholera germ has not been isolated, the theory which assumes its existence best reconciles all the facts."

The most recent authoritative American writer, Dr. Stillé, expresses himself as follows:

> "In looking now over the field that has been traversed in the foregoing pages, and searching for some link that will unite in a consistent whole the causes, symptoms, and lesions of cholera, it is evident that only one factor can possibly be so described. That factor is the gastro-intestinal flux. This it is that produces the vomiting and the purging; that prostrates the patient and wastes away in a few hours the fullest and the firmest form; that chills the limbs and afterward the trunk; that thickens the blood so that the capillary vessels can no longer convey it, and that spreads a cyanotic shadow over the whole surface of the body; that cuts off the supply of blood from the lungs and heart; that paralyzes the nervous system, ganglionic as well as cerebro-spinal; that obstructs the kidneys and arrests their secretion; and that, acting through the several links of this pathological chain, becomes the cause of death. But the question still recurs, What is the cause of the gastro-intestinal flux? To this also, in the light of observation, it is possible to give only one answer. It is a specific poison which originates in Hindostan, and, being taken into the stomach and bowels, not only produces in the individual the symptoms and lesions of cholera, but is capable of multiplying itself and rendering infectious the discharges from the stomach and bowels of the subjects of the disease, so that it may be transmitted from one person to another round the whole circumference of the globe. Regarding the form and nature of that poison little or nothing is definitely established beyond what has already been stated as the result of Koch's observations. As far as they go, they harmonize with a long-prevalent opinion that the cholera poison consists of certain microscopic germs, which, on being received into the bowels, propagate their kind and destroy the epithelium."

But against the somewhat exclusive view regarding the importance of the gastro-intestinal transudation, we may cite those "*foudroyant*" cases which kill without the previous development of a copious flux. Evidently the system can be so overwhelmed by virulent ptomaines or other poisonous products, that the "one factor" of Stillé remains undeveloped. But for the majority of cases Stillé's explanation is completely satisfactory, and indeed the only rational one that can be given in the light of our present knowledge.

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[1] Principles and Practice of Medicine. Philadelphia, 1881.

[2] On the Parasitic Doctrine of Epidemic Cholera. New York Medical Journal, October 25, 1884.

[3] A Treatise on the Practice of Medicine. By Roberts Bartholow, M.A., M.D., LL.D. New York, 1881, p. 731.

From a study of Asiatic cholera, more particularly as it appeared during the New York epidemic of 1866, Dr. Charles A. Leale,[1] of that city, concludes that:

> "Asiatic cholera only appears in America as an epidemic, which in two or three years exhausts itself. Its cause is dependent upon a peculiar bacillus or ferment, which, when planted in a suitable soil, causes malignant cholera. The experience of a very large proportion of the profession years ago empirically demonstrated that a decided acid reaction of the secretions of the stomach and bowels prevented an attack.
>
> Asiatic cholera is a self-limited disease, attacking all the races of mankind and at all ages; it is of very short incubation and duration; it may prove fatal as rapidly as in three hours from the time of apparent health; it is amenable to treatment and good nursing."

The same writer also relates a number of events, personally witnessed by him, which forcibly illustrate that even under the most favorable conditions the disease does not arise *de novo*. Concerning a certain voyage across the Atlantic on board an ocean steamer, of which he was the medical officer, Dr. Leale says:

> "Now surely here, in such a reekingly foul atmosphere, where fright and dread were apparent on all sides, we had many factors incorrectly stated by some to be causes of cholera, but the germ of cholera was not present; and, therefore, although there was a most prolific soil, yet not one case of Asiatic cholera occurred during the entire voyage."

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[1] The New York Medical Journal, Jan. 3, Jan. 24, and Feb. 21, 1885

CHAPTER XXI.

THE DOCTRINE OF KOCH.

As the result of a long series of investigations into the nature of cholera, undertaken by Dr. Robert Koch in Egypt during the epidemic of 1883, in India in 1884, and again in France during the recent visitation of 1884, the German inquirer announced certain definite views concerning the micro-parasitic nature of the disease.

The different stages of progress made in the investigations of the German cholera commission, of which Koch was the head, were communicated in a series of official reports to the German government. But what is now universally known as Koch's doctrine was embodied in an address delivered by him at the memorable Berlin cholera conference, held on the 26th of July, 1884. At this meeting many of the leading German savants, including authorities like Virchow, Hirsch, Eulenburg, Leyden, von Bergmann and others, had assembled in order to hear Koch's statements and to discuss the subject in all its bearings. The address of Koch was the principal event of this conference, that already may be said to mark an epoch in the history of Asiatic cholera.

Koch's theory has indeed formed the starting and returning point of almost all the later cholera researches, down to the most recent inquiries of the English commission.

No apology, therefore, is needed for here introducing this address[1] almost completely in place of merely giving a brief summary of the German author's views.

Koch opened his address by pointing out that—

> for sanitary measures, we require bases of as firm a foundation as possible. It is not only a question of very costly institutions, but of the happiness and misery of many people. This is most especially true for protection from pestilences, in which, it can be said without exaggeration, the most important sanitary efforts are being engaged. We should therefore suppose that, in the struggle against pestilences, people would start from thoroughly established and scientifically elaborated facts. But unhappily this is not everywhere the case, and especially with regard to cholera such a firm basis is wanting. It is true that a host of views on the nature of cholera, and its mode of spreading and infection, have been expressed, and various theories have been propounded concerning it; but the opinions are still so very divergent, they are so diametrically opposed, that we cannot take them, without examination, as supports or starting points for the measures we wish to institute in combating this plague.

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[1] It was published in the leading German medical periodicals, and has been translated into many foreign languages. The editor has used, with certain necessary modifications and corrections, the language of the English translation which appeared in the British Medical Journal of August 30 and September 6, 1884.

It is asserted, on the one hand, that cholera is a specific disease originating in India; on the other hand this is disputed, and it is held that cholera can also arise spontaneously in other countries, and is not dependent on a specific cause. Some hold that cholera is only introduced by the cholera-patient and his effects; others say that it can be spread by merchandise, by people in good health, and by currents of air. Equally contradictory opinions exist regarding the importance of drinking-water as a vehicle for conveying the infectious matter, and concerning the influence of the conditions of the soil, as well as in regard to the question whether or not the infectious matter is contained in the dejecta of the patient, and finally on the duration of incubation. But all these are precisely points of the greatest importance for the protection against cholera. And a successful resistance to the disease will not be possible till some unity of opinion has been arrived at on these fundamental questions of the etiology of cholera.

Now the etiology of this disease has profited little from the progress which we have made in the knowledge of the causation of other infectious diseases. This progress has developed chiefly in the last ten years; and during that period there has been no opportunity of investigating cholera—at least not in Europe, or in adjacent countries. But in India, where the prevalence of cholera could have continuously afforded material for investigation, nobody has been found to occupy himself with this task by applying the new methods of investigation.

In this respect it was therefore not unfavorable that cholera broke out last year in Egypt, and that opportunity was thus given for studying the nature and mode of infection of this disease before it arrived on European soil. This opportunity was utilized by various governments, which sent out expeditions to investigate the nature of cholera. I had the honor of superintending one of these expeditions.

When I undertook this commission I was fully aware of the difficulties of the task. Properly speaking, nothing was as yet known of the infectious matter of cholera. It was not known where to look for it—whether it existed in the intestinal canal, or in the blood, or elsewhere. It was, further, not known whether one had to deal in this case also with bacteria, or with fungi or something similar, or with animal parasites—*e. g.*, amœba. It is true that, in this respect, there were not such important difficulties met with as in another direction, where I least expected to find them.

I had pictured to myself the pathological appearances constructed according to the descriptions of the standard text-books; and had supposed that the intestine in cholera showed very few modifications, and that it was filled with a fluid resembling rice-water. The autopsies that I had previously seen I had already half forgotten, so that I could not correct this false idea. Hence I was at first rather surprised and uncertain when I came to see something else in the intestine. In the first autopsies, it was at once evident that, in the majority of cases, extremely great and striking modifications were to be found. Other cases again, showed only slight changes; and, finally, I came across cases which in some degree corresponded to the type given in the ordinary books of instruction. In spite of the most careful investigation of all the other organs and of the blood, nothing was to be found which could lead one to suppose that the infectious material was to be found there. My attention, therefore, was concentrated exclusively on the modifications in the intestines.

Koch then proceeds to give an account of the appearances of cholera intestines, a description of which will be found elsewhere under the heading of "Morbid Anatomy." He then continues as follows:

When we examined the intestine and its contents under the microscope, it was seen that in some cases, especially in those in which Peyer's glands were red at the edge, an invasion of bacteria corresponding to this redness had taken place. The diagram on next page illustrates this appearance.

The bacteria had partly forced their way into the utricular glands, partly pushed themselves between the epithelium and the basement-membrane, thereby lifting the epithelium as it were. In other parts, it was seen that they had forced their way deeper into the tissue. Then cases were found in which, behind these bacteria, which had a special appearance with regard to size and shape, so that one could distinguish them from other bacteria, and devote special attention to them, various other bacteria had forced their way into the utricular glands and the surrounding tissue, *e. g.*, large thick bacilli and very thin bacilli. Thereby conditions are produced similar to those in necrotic diphtheritic changes of the mucous membrane of the intestine, and in typhoid ulcers, where afterward other non-pathogenic bacteria force their way into the tissue rendered necrotic by pathogenic bacteria. We were, therefore, from the very beginning, obliged to look upon these first-mentioned bacteria as not altogether unimportant for the cholera-process, while the other changes gave the impression of being secondary; for the bacteria first described always advanced beyond the others, they forced their way farther in, and gave the impression as if they had smoothed the way for the other bacilli.

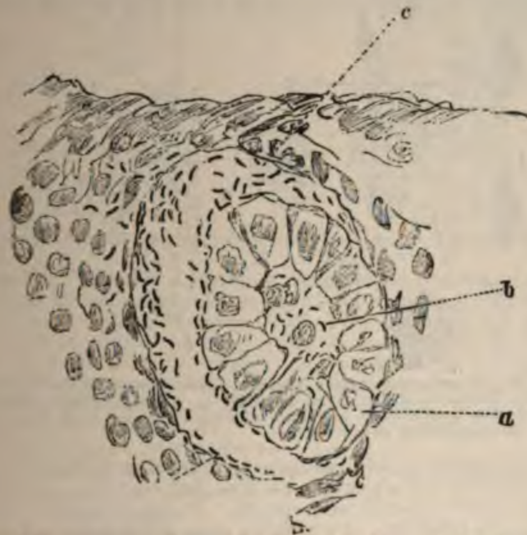
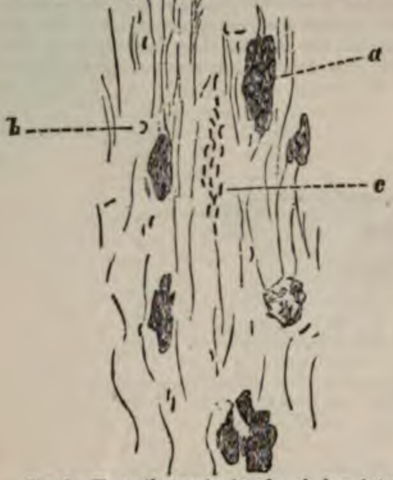


FIG. 1.—Section of the mucous membrane of a cholera-intestine. A utricular gland (*a*) is diagonally cut through. In its interior (*b*), and between the epithelium and basement-membrane (*c*) numerous comma-bacilli. 600 magnifying power.

With regard to the contents of the intestine, at first no clear idea could be formed, as the only cases which came before us for examination were not suitable; in these, also, the contents of the intestine were already putrid and bloody. An enormous quantity of various bacteria was found in these contents, so that there was no possibility of attending to the real cholera-bacilli. Not till I had dissected a number of acute and uncomplicated cases, in which no hæmorrhage had as yet set in, and in which the contents of the intestines had not yet undergone putrid decomposition, did I recognize that, the purer and fresher the cases, the more did a special kind of bacteria prevail in the contents of the intestines. It was soon clear that these were the same bacteria which I had seen in the mucous membrane. This discovery naturally turned my attention more and more to these bacteria. I investigated them in all kinds of ways, in order to establish their special peculiarities. I am able to give the following information regarding them.

These bacteria, which I have called comma-bacilli, on account of their peculiar shape, are smaller than the tubercle-bacilli. The cholera-bacilli are about half, or at most two-thirds, as long as tubercle-bacilli, but much more bulky, thicker, and slightly curved. This curve is generally not more marked than that of a comma; but sometimes it is larger, becoming semicircular, as in the adjoining figure. In other cases, it is seen that the curve is doubled, that one comma is attached to another, but in an opposite direction, so that it forms the shape of an S. I think that in both cases two individual ones after being divided have remained stuck together, and accordingly give the appearance of a more marked curve

But in the artificial cultivations, beside these, another very remarkable form of development of the comma-bacillus is to be found, which is very characteristic of it. The comma-bacilli frequently grow in threads of longer or shorter length. But they do not then form straight threads, like other bacilli, for instance, anthrax-bacilli, or, as it appears in the microscopic picture, simply wavy threads, but very tender long spirals, which, as far as their length and the rest of their appearance are concerned, bear the closest resemblance to the spirochætæ of relapsing fever (see Fig. 4). I could not distinguish one from another if I had them side by side.



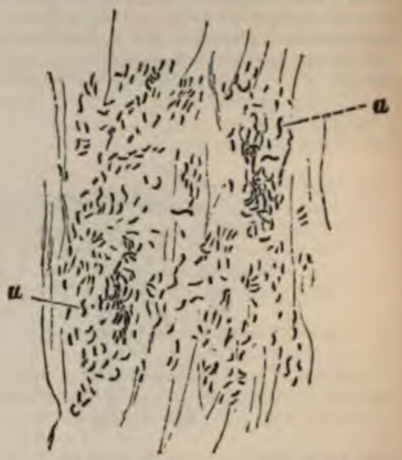


FIG. 2.—From the contents of a cholera-intestine. Core of necrotic epithelia (*a*). Semicircular comma-bacillus (*b*). Characteristic grouping of bacilli (*c*). 600 magnifying power.

FIG. 3.—Object-glass preparation. Cholera dejecta on damp linen (two days old). At (*a*) S-shaped bacilli. 600 magnifying power.

Owing to this peculiar form of development, I am also inclined to the view that the comma-bacillus is not a genuine bacillus, but that it is, properly speaking, a transition form between bacilli and spirilla. Perhaps, indeed, we have here to deal with a genuine spirillum, of which we have a fragment before us.

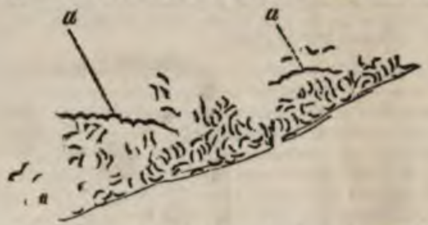


FIG. 4.—Object-glass preparation. From the edge of a drop of meat-broth, with pure culture of comma-bacilli. Long screw-shaped threads (*a*). 600 magnifying power.

Comma-bacilli can be cultivated in meat-broth. They grow in this liquid very quickly, and in great numbers. This property of theirs can be utilized for studying their other qualities, by examining, with a strong magnifying power, a small drop of meat-broth cultivation on the object-glass. It is then seen that the comma-bacilli move in a very lively manner. When they are collected together at the edge of the drop, and are moving about among one another, they look like a swarm of dancing midges, and the long spiral threads appear also moving in an animated manner, so that the whole affords a strange and extremely characteristic picture.

But the comma-bacilli also grow in other liquids, and especially, speedily and in great abundance, in milk. They do not make milk curdle, and do not precipitate the casein, which many other bacteria, that can also be raised in milk, do. Hence the milk looks quite unchanged. But if you take a small drop from the surface, and examine it under the microscope, it teems with comma-bacilli. They also grow in the serum of blood, in which they very quickly develop, and multiply in great numbers. Again a very good soil for the reproduction of comma-bacilli is food-gelatine. This gelatine can serve for facilitating and securing the discovery of comma-bacilli. For the colonies of comma-bacilli assume, in the gelatine, a most characteristic and definite form, which, so far as I can discern, and as far as my experience reaches, no other kind of bacteria assumes in like manner.

The colony looks, when it is very young, like a very pale and tiny little drop, which is, however, not quite circular (the shape generally assumed by these bacteria-colonies in gelatine), but has a more or less irregularly bordered, hollowed out, in parts also rough or jagged shape. It also has, at a very early stage, rather a granular appearance, and is not of such regular character as other colonies of bacteria.

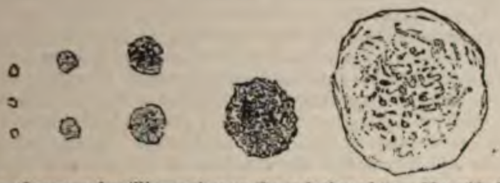
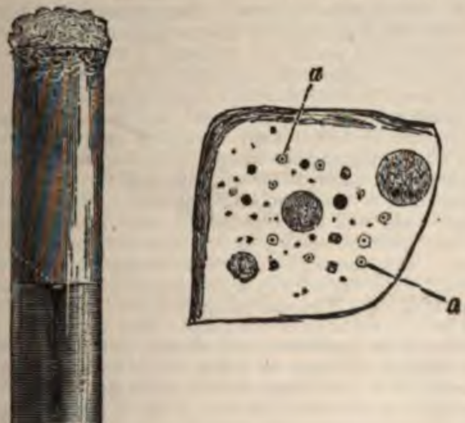


FIG. 5.—Colonies of comma-bacilli growing on the gelatine-plate. Magnified 80 times.

When the colony becomes somewhat larger, this granulation becomes more and more evident; at last it looks like a little heap of strongly refracting granules. I might best compare the appearance of such a colony with the appearance of a little heap of pieces of glass. As they grow, the gelatine liquefies in the immediate neighborhood of the bacteria colony, and this latter at the same time sinks down deeper into the mass of gelatine. A funnel-shaped cavity is thus formed in the gelatine, in the midst of which the colony is seen as a little whitish point. This appearance is also quite peculiar. It is seen, at least in this manner, in very few other kinds of bacteria, and, as far as I know, never so marked as with the comma-bacilli. The sinking of the colonies can be best observed when carrying out an artificial cultivation. A suitable colony is selected on the gelatine plate, under a microscope with a low power; it is touched with a platinum wire, previously heated; the bacilli are transferred by the wire into a test-tube with gelatine, and this is closed with sterilized wadding. A cultivation of this kind then grows in the same manner as the colony on the gelatine-plate. I am in pos-



FIGS. 6 AND 7.

FIG. 6.—Funnel-shaped sinking in the gelatine at the inoculation point in the test-tube.
FIG. 7.—Natural size of the colonies as they appear on the gelatine plate.

session of a numerous collection of artificial cultivations of bacteria, made in this manner; but I have never seen in their case such changes as the comma-bacilli cause after being transferred into the gelatine. Here, also, as soon as the cultivation begins to develop, you see a little funnel, which marks the point where the inoculation took place. By degrees, the gelatine liquefies in the neighborhood of this point of inoculation; then the little colony is plainly seen extending itself more and more. But a deep spot, sunken in, always remains, which looks in the partially liquefied gelatine, as if an air-bubble were hovering over the colony of bacilli. It almost gives the impression as if the bacilli-vegetation not only caused a liquefaction of the gelatine, but also a speedy evaporation of the liquid formed. We already know a number of other kinds of bacteria which, in quite the same manner, gradually liquefy the gelatine in test-tubes, starting from the point of inoculation. But in these cases there is never such a cavity nor this bubble-like hollow space. I must also mention that the liquefaction of the gelatine, starting from a single isolated colony—the best way of observing it in a layer of gelatine, which is spread out on the glass plate—never spreads very far. The dimension of the liquefied district of a colony may be estimated at one millimetre. Other kinds of bacteria can liquefy the gelatine to a much greater extent, so that a colony attains a size of one centimetre in diameter, and more. In the cultivation of comma-bacilli, made in test-tubes, the liquefaction of the gelatine extends by degrees and very slowly, starting from the point of inoculation; and continues in such a manner that, after about a week, the whole contents of the tubes have become liquid. Unimportant as all these qualities seem in themselves, special weight is to be laid on them, because they serve to distinguish comma-bacilli from other kinds of bacteria.

Comma-bacilli can also be cultivated on Ceylon moss (*Agar-agar*), to which meat-broth and pepton are added. This agar-agar jelly is not liquefied by the comma-bacilli. They can also be raised on boiled potatoes—a fact which is very important for certain questions. They grow on potatoes like the bacilli of glanders. The latter form a thin, pulpy, brownish coating on the potatoes. The cultivation of comma-bacilli, when grown on potatoes, look like this, but not colored so intensely brown, but rather light, grayish brown.

Comma-bacilli flourish best at temperatures between 86° and 104° Fahr., but they are not very susceptible to lower temperatures. Experiments have been made on this point, which show that they can grow very well at 62.5° F., though more slowly. Below that point the growth is very small, and seems to cease below 60.8° F. In this respect the comma-bacilli remarkably resemble anthrax-bacilli, which also have this minimum temperature as the limit of their growth-power. Once I made an experiment to test the influence of lower temperatures on comma-bacilli, and to see if they are, at a very low temperature, not only hindered in their development, but also if they cannot possibly be killed. For this purpose, an artificial cultivation was exposed for an hour to a temperature of 14° F.; during this time it was completely frozen. When part of it was put into the gelatine, there was not the least difference visible in the development or growth, so that they bear frost very well. It is not the same with the withdrawal of air and oxygen. They immediately cease to grow when deprived of air, and accordingly belong, if the division into aërobic and anaërobic bacteria be held as good, to the aërobic class. Any one can convince himself of this very simply by laying a piece of talc or mica over the glass plate, when the portion of the artificial cultivation has been placed on it in liquid gelatine, and when the gelatine is beginning to stiffen; the talc or mica must be as thin as possible, and must cover at least one-third of the gelatine surface in the middle. The piece of mica, owing to its elasticity, adheres completely to the surface of the gelatine, and thus cuts off the air on the portion covered. Then, as soon as the development of the colonies follows, it is seen that the development only takes place where the gelatine is not covered, and only a trifle, about two millimetres, under the mica-plate, up to which point the air has been able to force its way. But under the mica-plate itself nothing grows. Extremely small colonies, invisible to the naked eye, do, it is true, appear, which probably owe their origin to the oxygen existing in the gelatine but they do not increase in size afterward. An experiment was made in another manner. Little glasses containing food-gelatine, which had been inoculated with comma-bacilli, were placed under an air-pump, and others prepared in the same manner were kept outside the air-pump. It was then seen that those under the air-pump did not grow, but only those outside it. But when those that had been under the air-pump were again placed in the air, they began to grow. Hence they had not died; they only wanted the necessary oxygen to be able to grow. The same occurs when the cultivations are brought into an atmosphere of carbonic acid. While the cultivations that have been kept for comparison outside the carbonic acid atmosphere grow in the usual manner, those that are in a stream of carbonic acid remain undeveloped. But in this case, also, they do not die; for after having been for some time in the carbonic acid, they begin to grow immediately after they have come out of it.

On the whole, comma-bacilli, as I have repeatedly observed, grow very rapidly. Their vegetation speedily reaches a maximum, at which it only remains stationary for a short time, then diminishing again very quickly. The comma-bacilli, when wasting away, lose their shape; they appear at one time shriveled, and at another time swollen, and in this state they are not at all, or only slightly, susceptible to color. The peculiar conditions of vegetation of comma-bacilli can be best observed by bringing substances which are rich in comma-bacilli, but also contain other bacteria, *e. g.*, the contents of a cholera-intestine or cholera-dejecta, in contact with moist earth, or by spreading them out on linen, and keeping them in a damp condition. Comma-bacilli then increase in a very short time, *e.g.*, in an extraordinary manner in twenty-four hours. Other bacteria that exist with them are at first stifled by the comma-bacilli, a natural pure culture is formed, and, on examining with the microscope the mass that is taken from the surface of the damp earth or linen, preparations can be obtained which show almost exclusively comma-bacilli.

But this luxuriant growth of comma-bacilli does not last long. After two or three days they begin to die off, and other bacteria then increase. The conditions become the same as in the intestine itself. There also a rapid multiplication takes place; but when the real vegetation period, which only lasts for a short time, is over, and especially when exudations of blood into the intestine take place, the comma-bacilli disappear, and the other bacteria, especially putrefaction-bacteria, commence to develop in their place. I am, therefore, almost inclined to believe that if the comma-bacilli were brought at first into a putrefied liquid which contained a great deal of the products of vital changes of other bacteria, and especially of putrefaction-bacteria, they would not come to development, but would soon die off. But, so far, sufficient experiments have not been made on this point. It is only a supposition which I make, supported by my experiences of other bacterical cultivations. The point is important, however. For it is not a matter of indifference whether the comma-bacilli, if they come into a sink, find a good or a very bad soil for reproduction. In the first case, they would multiply and would have to be destroyed by methods of disinfection; but in the latter case they would die off, and there would be no necessity for disinfecting. I am inclined to hold the latter view, as borne out by all the experience I have so far had.

The comma-bacilli flourish best in liquids which do not contain too small a quantity of nutritive matters. Several experiments have been made on this point. Dilutions of meat-broth with an alkaline reaction were prepared, and a quantity of comma-bacilli was placed in them. In one of these experiments, the meat-broth, after a five-fold dilution, proved to be no longer a nutritive solution. In other experiments, the bacilli grew in a ten-fold dilution.

In these cultivation experiments, it was further seen that the nutritive substances—at least, the gelatine and meat-broth—must not be acid. As soon as the gelatine shows only a trace of acid reaction, the growth of the comma-bacilli is very stunted. If the reaction be in a marked degree acid, the development of the bacilli completely ceases. It is at the same time noteworthy that it is not all acids that seem to act unfavorably on the comma-bacillus. For the cut surface of a boiled potato is known to have an acid reaction. Nevertheless, comma-bacilli grow very luxuriantly on potatoes. Hence, one cannot say, straight off, that all acids hinder the growth; but, in any case, there are a number of acids which have this effect. In meat-broth it is probably lactic acid, or an acid phosphate.

As the influence of substances that prevent the development of the growth of comma-bacilli is one of no small interest, a number of other substances have been examined with regard to this point.

Iodine is known to have been characterized by Davaine as a very intense poison for bacteria, and, under certain circumstances, correctly so. Davaine made his experiments by diluting, to a very great extent, a liquid containing anthrax-bacilli, *e. g.*, anthrax blood, until he finally had nothing but pure water, in which very few anthrax-bacilli were suspended. He added iodine to this liquid, and then it was seen that the anthrax-bacilli were killed by an extremely small quantity of iodine; but in practice the conditions are quite the reverse. We never have to stop the development of infectious matters in pure water, but in the alkaline contents of the intestines, or in the blood, or in the juices of the tissues, and the iodine does not remain free in these, but combines at once with the alkalies. The investigation of the influence of iodine on the comma-bacilli was made by adding iodine-water to meat-broth, which was just suitable as a nutritive liquid. Iodine dissolves in water in the proportion of about 1 in 4,000. One cubic centimetre of this iodine-water was mixed with ten cubic centimetres of meat-broth, but this did not hinder the growth of the bacilli in the least; the limit at which iodine prevents the bacilli from developing must, therefore, lie far below the amount used in this experiment. But it seems to me unnecessary to make any more experiments on this point, as, in practice, larger quantities of iodine than this cannot be given.

Alcohol stops the development of comma-bacilli only when one part is added to ten parts of a nutritive fluid, *i. e.*, in the proportion of ten per cent. This is a concentration which also cannot be practically utilized. Common salt was used in the proportion of 2 per cent. without the growth of the comma-bacilli being hindered. Sulphate of iron only hinders the growth when two per cent. is added to the nutritive fluid. In regard to this substance, which has been very much used for purposes of disinfection in time of cholera, I would state the fact that a proportion of two per cent. is necessary before it acts as a preventive to development. The comma-bacilli are not yet killed by the sulphate of iron in this concentration. The property which sulphate of iron has, of hindering the development of the bacilli, is, perhaps, thus explained. The peptone and albuminates of the nutritive solution, which serve as food for the bacteria, are driven out; for, by adding two per cent. of sulphate of iron, an abundant precipitate is formed in the nutritive solution. Possibly, also, the acid reaction that takes place has a checking effect on the growth. Accordingly, this substance seems not to possess any specific effect on the bacteria, and certainly not to be a real material for killing or disinfection. I consider it indeed possible that, with such a substance, exactly the opposite of what is intended may be obtained. Given the case that the contents of a cesspool had to be disinfected, into which it was known that comma-bacilli had found their way: according to my view, the process of putrefaction that goes on of itself in the cesspool, is sufficient to kill the comma-bacilli. But if sulphate of iron be added till there be an acid reaction, and the process of putrefaction is thereby arrested, nothing else is obtained but cessation of the growth of the bacteria and of the comma-bacilli. The bacteria are by no means killed by this method; and as for the comma-bacilli, they are removed from the influence of the putrefaction bacteria which are injurious to them, and are preserved instead of being destroyed.

This example is a very good one to show that the substances for disinfection must be correctly judged and examined precisely on this point, and that we have to distinguish between what only arrests putrefaction and what really kills bacteria. The former may very possibly serve as a means of preserving infectious matters.

I will only mention the limit of the power other substances possess of arresting the development of comma-bacilli: Alum, 1 : 100; camphor, 1 : 300. I had expected a stronger effect from camphor, but several careful experiments have shown that this substance possesses only a very slight influence on comma-bacilli. Carbolic acid, 1 : 400. This figure nearly agrees with what we know of the influence of carbolic acid on other bacteria. Peppermint-oil, 1 : 2,000. Sulphate of copper, 1 : 2,500. This substance has a very powerful effect. But if we want to calculate how much sulphate of copper must be given in order to check the growth of the bacilli in the intestinal canal, we should arrive at quantities which could not be given to a human being. Quinine, 1 : 5,000; and corrosive sublimate, which is here again seen to exceed all other substances in power, 1 : 100,000.

In these experiments on the influence of substances for arresting the development of comma-bacilli, the striking fact became evident that comma-bacilli die easily when dried. These experiments were made by letting a very small drop of a substance containing bacilli dry on an object-glass, and a large supply of these object-glasses was immediately prepared for a series of experiments. A drop of the liquid which was to be examined was then placed upon such an object-glass, and left for development in the hollow object-holder. Having proceeded in this manner, in no single preparation did anything grow that had received meat-broth as nutritive fluid, nor in a striking manner in the test-preparations either. At first I did not know what caused the absence of growth, and thought that the broth must be the cause of it, for I had never met with anything like this before in the case of other bacteria. For instance, anthrax-bacilli can be kept in stock for a long time dry on object-glasses; they retain vitality from half a week to nearly a whole week in this manner. As, however, the meat-broth on examination proved to be unexceptionable, we had to examine whether the comma-bacilli had not probably died off owing to being dried upon the object-glass. In order to obtain certainty on this point, the following experiment was made: A number of object-glasses were provided with a small drop of substance containing bacilli. The drop dried up in a few minutes. One object-glass was now diluted with a drop of meat-broth after an interval of a quarter of an hour, another after an interval of half an hour, another after an interval of an hour, and so on. Then it was seen (and I made several series of experiments) that the comma-bacilli did come to development on the dried glass plates that had laid a quarter, a half, and a whole hour; but after two hours they sometimes died off; after three hours, I could not keep the bacilli alive in these experiments. Only when compact masses of bacilli cultivations—for instance, when the pappy substance of a cultivation made on potatoes was dried—did the bacilli retain vitality for a longer time; clearly because in this case complete desiccation followed much later. But, also, under these conditions I have never succeeded in preserving the bacilli alive in a dried state longer than twenty-four hours.

This result was in so far important, as by its means it could easily be tested whether the bacteria have a permanent state. We know that other pathogenic bacteria—for example, anthrax-bacteria, which form spores—can be preserved for years in a dry state on an object-glass without their dying. We know also of other infectious substances, with whose nature we are not yet accurately acquainted—for example, the infectious matters of small-pox and of vaccine—which can be kept in a dried state for several years, still retaining their power of infection. If now the comma-bacilli, which, as such, are unexceptionally speedily killed by dying, pass into a lasting condition under some circumstances, that would be very soon shown during the process of dying.

This is one of the most important questions for the etiology of an infectious disease, and especially so for cholera. The investigation of this point has therefore been made in the most careful manner possible. Above all, cholera dejecta and the contents of the intestines of cholera corpses were left in a damp condition on linen, in order that the comma-bacilli might develop under the most favorable circumstances. After certain intervals of time, pieces of the linen were dried—for example, after twenty-four hours, after a few days, after several weeks—to see if, during this period, any condition of permanence had been established. For infection through cholera linen affords the only undisputed example of the presence of an effectual infectious substance which adheres to a special object. If there were a permanent state to be found anywhere, it must have been found on cholera linen.

But in none of these cases was a permanent state discovered. When the dried things were examined, it was seen that the comma-bacilli had died off. Then, further, the dejecta were placed in earth, being either mixed with earth or spread on the surface, which was either kept dry or moist; they were mixed with marsh-water, and were also left to decay without anything being added to them. In gelatine-cultivations, the comma-bacilli have been cultivated up to six weeks; also in serum of blood, in milk, on potatoes, on which anthrax-bacilli are known to form spores extremely rapidly and in great abundance. But we have never obtained a permanent state of comma-bacilli. As we know that the majority of bacilli have a permanent state, this result must appear very striking. But I would remind you, as I mentioned before, that we have most probably to deal here with a micro-organism, which is not a genuine bacillus at all, but is more allied to the group of screw-shaped bacteria, spirilla. Now we do not know of any permanent state of spirilla as yet. Spirilla are bacteria which depend for their existence exclusively on liquids, and do not, like anthrax-bacilli, vegetate under certain conditions in which they have for once to endure a dry state. It therefore seems to me, as far at least, as my experience goes, that there is no prospect of finding a permanent state of comma-bacilli. I shall, later on, explain that the absence of a permanent state perfectly coincides with the experiences of the etiology of cholera.

If one consider all the qualities of the comma-bacilli that I have hitherto described, one must be convinced that they belong to a special well-characterized species of bacteria; and that by means of their characteristic qualities they can easily be recognized and distinguished from other bacteria.

After obtaining this conviction, it was above all important to establish the relations between the comma-bacilli and the real process of cholera; and, first, I had to investigate whether they are to be found in all cases of cholera, and whether they are absent in all other cases; that is, whether they belong exclusively to cholera. In this direction as large a series of cases as possible was thoroughly investigated. In Egypt, ten *post mortem* examinations could be turned to account. It is true these were only microscopically examined; for I was not then sufficiently acquainted with the qualities of the comma-bacilli, which they show while growing in food gelatine, to be able to make use of the gelatine-process for proving the presence of the bacilli. But I was convinced by careful microscopic investigation of the presence of the comma-bacilli in all these cases. In India, forty-two *post mortem* examinations were made, both microscopically and by cultivations in food gelatine, and in no case were the bacilli absent. In a series of cases, which had been very acute, an almost pure cultivation of comma-bacilli was met with in the intestinal canal. Further, in India, the dejecta of thirty-two cholera patients were similarly examined, and each time comma-bacilli were present in them. The liquid vomit of cholera patients was also often examined; but comma-bacilli were only found twice in the vomit, and in these cases the quality of the vomit enabled us to conclude that it was not properly the contents of the stomach, but contents of the intestine, which had been driven upward by abdominal pressure, and evacuated. The liquid had an alkaline reaction and looked exactly like the contents of the intestine. I have also found comma-bacilli in eight other *post mortem* preparations, some of which I had previously had sent me from India, and others I had received from Alexandria, from Dr. Kartulis and Dr. Schiess Bey. Finally, I recently made two *post mortem* examinations at Toulon, together with Dr. Straus and Dr. Roux; and in these cases also, as well as in the dejecta of two patients, comma-bacilli were found. In these two *post mortem* examinations at Toulon we had to do with exceptionally characteristic and acute cases. One of the men, a sailor, was to have been dismissed from the hospital on the same day, as convalescent from malaria; but this could not be done, for at about eleven o'clock in the morning he had an attack of cholera. He died in the afternoon at three, and the corpse could be dissected by half-past three. I will here observe that in almost all the cases examined by me the *post mortem* examinations have been made a very short time after death. We have often made the dissections immediately after death; in most cases two or three hours, at latest, after death; so that *post mortem* putrefaction could not yet have had the effect of changing the condition of the intestine or of its contents. In the case mentioned, as in those of a number of earlier *post mortem* examinations, we could also convince ourselves of the presence in the intestine, in very acute cases, of almost a pure cultivation of comma-bacilli. I was able to demonstrate this fact to Dr. Straus and Dr. Roux, who had not as yet succeeded in proving the existence of comma-bacilli either microscopically or on firm nutritive soil. These gentlemen had always been of opinion, Dr. Straus told me, that a special trick in the preparation was necessary in order to color and cultivate the comma-bacilli. Then, however, they were convinced that nothing is more simple than this, if only a pure and uncomplicated case be chosen for investigation.

In the second *post mortem* examination, also, in which I took part at Toulon, the comma-bacilli were found in the intestine in almost a pure cultivation. I then asked Dr. Straus to take this opportunity of showing me the micro-organisms which, according to his view, are to be found in cholera blood. But these appearances were not to be found in either case.

If we add all these cases together, nearly one hundred have been examined with regard to the presence of comma-bacilli, and the bacilli have been found in all of them. But the investigation has not only proved the existence of the comma-bacilli, but, as I have repeatedly hinted, they always stand in exact proportion to the cholera-process itself; for, where the real cholera-process proper caused the greatest modifications in the intestine, namely, in the lower section of the small intestine, they were to be found in greatest numbers; from these upward they diminished more and more. In the least complicated cases, they appeared almost like pure cultivations. The older the case, and the more secondary modifications have taken place in the intestine, the more do they recede into the background.

In accordance with the cholera material that I have so far examined, I think I can now assert that comma-bacilli are never absent in cases of cholera; they are something that is specific to cholera.

As a test, a considerable number of other corpses, dejecta from patients and persons in good health, and other substances containing bacteria, were examined to see if these bacilli, which were never missing in cases of cholera, might, perhaps, occur elsewhere also. This is a point of the greatest importance in judging the causal connection between comma-bacilli and cholera.

Among these objects for investigation was the corpse of a man who had had cholera six weeks before, and had afterward died of anæmia. There was no further trace of comma-bacilli to be found in his intestines. The dejecta of a man who had had an attack of cholera for eight days previously were also examined; his stools were already beginning to be consistent; in this case also comma-bacilli were absent.

I have also thoroughly examined more than thirty corpses, in order to convince myself more and more that these bacilli are really only found in cases of cholera. Corpses of those who had died of affections of the intestines, *e. g.*, of dysentery or of those catarrhs of the intestines frequently mortal in the tropics, were selected for this purpose; also cases with ulceration in the intestine, a case of enteric fever, and several cases of bilious typhoid.

In the last-named disease, the modifications in the intestines are at first sight very similar to those which take place in severe cases of cholera, in which hemorrhage of the intestine occurs. The small intestine is in the lower section infiltrated by hemorrhage; but, strange to say, this change affects rather the Peyer's patches in bilious typhoid, while in cholera they are very little changed.

In all these cases where we had to deal chiefly with diseases of the intestine, no trace of comma-bacilli was to be found. Experience teaches that such affections of the intestine make people especially liable to cholera. So one might have presupposed that comma-bacilli, if they were to be found anywhere else, must be found in these cases. Beside these, dejecta of a large number of dysenteric patients were examined without the comma-bacilli ever being met with. We continued these investigations afterward in Berlin, and examined a considerable number of various dejecta, especially of children's diarrhœa, as well as that of grown-up persons; saliva also, and the mucus that adheres to the teeth and tongue, and which abounds in bacteria, for the purpose of finding comma-bacilli, but always without success. Various animals were also examined with this view. Because a complication of symptoms very similar to those of cholera can be obtained by arsenical poisoning, animals were poisoned with arsenic, and afterward examined. A great number of bacteria were found in the intestines, but no comma-bacilli. Nor were they found in the sewage from the drains of the town of Calcutta, in the extremely polluted water of the river Hoogly, in a number of tanks which lie in the villages and between the huts of the natives, and contain very dirty water. Everywhere, where I was able to come across a liquid containing bacteria, I examined it in search of comma-bacilli, but never found them in it. Only once did I come across a kind of bacterium which at first sight bore a strong resemblance to comma-bacilli, and that was in the water which, at high water, floods the land of the salt water lake that lies to the east of Calcutta; but, on a closer inspection, they appeared larger and thicker than comma-bacilli, and their culture did not liquefy gelatine.

Beside these observations, I have had a considerable experience in bacteria, but I cannot remember ever having seen bacteria resembling the comma-bacilli. I have spoken to several people who have made a great number of cultivations of bacteria, and have also had experience, but all have told me that they have not yet seen such bacteria. I therefore think I may say positively that the comma-bacilli are constant concomitants of the cholera process, and that they are never found elsewhere.

The question to be answered now is, how we are to represent the relation between the comma-bacillus and the cholera-process. In answering this question, three different assumptions may be made. It can be said, first, that the cholera-process favors the growth of comma-bacilli by preparing the nutritive soil for them, and that, consequently, so striking an increase of precisely this kind of bacteria takes place. If this assertion be made, then one must start with the presupposition that everybody already has comma-bacilli in his body at the time when he is attacked by cholera; for they were found in the most various places in India, in Egypt, in France, and in people of most various origin and nationality.

On this assumption, this kind of bacteria must be one of the most widely spread and most usual kind. But the contrary is the fact; for they are not found, as we have seen, either in those persons who are suffering from other diseases, or in persons in good health, or, except in man, in places favorable for the development of bacteria; they are always found only where cholera is prevailing. This assumption cannot, therefore, be regarded as admissible, and must be dropped.

Secondly, one might try to explain the regular concurrence of comma-bacilli and the cholera process in this way: that conditions are created by the disease, by means of which, among the many bacteria that are to be found in the intestine, one kind or another is changed, and assumes the qualities that we have observed in the comma-bacillus. But, in regard to this explanation, I must confess that it has no actual foundation whatever, and is a pure hypothesis. So far, we know of no transformation of one kind of bacteria into another. The sole instances of transformation in the qualities of bacteria rest on their physiological and pathogenic effects, not on their form. Anthrax-bacilli, for instance, when treated in a particular manner, lose their pathogenic effect, but they remain quite unchanged in form. In this instance we have an example of loss of pathogenic qualities. But this is precisely the opposite of what would take place by the transformation of harmless intestinal bacteria into dangerous cholera-bacilli. Of this latter kind of change from harmless into harmful bacteria, there is no instance that has ever been shown. Some years ago, when the investigation of bacteria was only in its first stage, such an hypothesis might with some degree of justification have been made. But the further the knowledge of bacteria has developed, the more certain has it been shown that, in regard to shape, bacteria are extraordinarily constant. With special reference to comma-bacilli, I will further remark that they retain the qualities above described when raised outside the human body. For instance, they were repeatedly cultivated, from one to another cultivation, in gelatine, to the number of twenty cultivations, and must have returned to the known forms of the common intestinal bacteria if they were not as constant in their qualities as other bacteria; but this was by no means the case.

There only remains the third assumption—namely, that the cholera process and the comma-bacilli stand in immediate connection with one another; and, in this respect, I know of no other supposition than that the comma-bacilli are the cause of the cholera process; that they precede the disease, and that they produce it. The opposite would be, what I have just explained, that the cholera process produces the comma-bacilli; and this is, as was shown, not possible. As far as I am myself concerned, the matter is clear, that the comma-bacilli are the cause of cholera.

Now it can certainly be demanded that, if this be the case, further proofs should be brought in support of it, and above all, that the cholera process should be produced experimentally by means of the comma-bacilli. Every imaginable effort has therefore been made to meet this demand. The only possible way of giving such a direct proof of the cholera-producing effect of comma-bacilli is to make experiments on animals, which, if we are to believe the statements of writers on the subject, can be done without any difficulty. It has been said that cases of cholera occurred among cows, dogs, poultry, elephants, cats and several other animals; but on closer examination these statements are found to be quite unreliable. As yet we have no certain instance of animals falling spontaneously ill of cholera in periods of cholera. All experiments, also, which have hitherto been made on animals with cholera substances have either given a negative result or, if they were said to give a positive result, they were not sufficiently supported by evidence, or were disputed by other experimenters. We occupied ourselves, nevertheless, in the most careful and detailed manner, with experiments on animals. Because great value must be laid on the results on white mice obtained by Thiersch, I took fifty mice with me from Berlin, and made all kinds of experiments on them, at first feeding them on the dejecta of cholera patients and the contents of the intestine of cholera corpses. We followed Thiersch's rules as accurately as possible, not only feeding them with fresh material, but also with the same food after the fluids had began to decompose. Although these experiments were constantly repeated with material from fresh cholera cases, our mice remained healthy. We then made experiments on monkeys, cats, poultry, dogs, and various other animals that we were able to get hold of; but we were never able to arrive at anything in animals similar to the cholera process. In precisely the same manner we made experiments with the cultivations of comma-bacilli; these were also given as food in all stages of development. When experiments were made by feeding the animals with large quantities of comma-bacilli, on killing them and examining the contents of their stomachs and intestines with a view to find comma-bacilli, it was seen that the comma-bacilli had already perished in the stomach, and had usually not reached the intestinal canal. Other bacteria are different in this respect, for a beautifully red colored micrococcus was found accidentally at Calcutta, which was easily recognized by its striking color, and was therefore especially suitable for such an experiment. This micrococcus was, at my request, given by Dr. Barclay, of Calcutta, to mice as food, and the contents of the intestines of these animals were placed upon potatoes. The red colonies of the micrococcus again formed, which had thus passed the stomach of the mouse uninjured. On the other hand, comma-bacilli are destroyed in the stomachs of animals. We were forced to conclude from this that the failure of these experiments by feeding the animals was due to this property of the comma-bacilli. The experiment was therefore modified by introducing the substances direct into the intestines of the animals. The belly was opened and the liquid was injected immediately into the small intestine with a Pravaz syringe. The animals bore this very well, but it did not make them ill. We also tried to bring the cholera-dejecta as high as possible into the intestines of monkeys by means of a long catheter. This succeeded very well, but the animals did not suffer from it. I must also mention that purgatives were previously administered to the animals in order to put the intestine into a state of irritation, and then the infecting substance was given without obtaining any different result. The only experiment in which the comma-bacilli exhibited a pathogenic effect, which therefore gave me hope at first that we should arrive at some result, was that in which pure cultivations were injected directly into the blood-vessels of rabbits or into the abdominal cavity of mice. Rabbits seemed very ill after the injection, but recovered after a few days. Mice, on the contrary, died from twenty-four to forty-eight hours after the injection, and comma-bacilli were found in their blood.

Of course, they must be administered to animals in large quantities; and it is not the same as in other experiments connected with infection, where the smallest quantities of infectious matter are used and yet an effect is produced. In order to arrive at certainty whether animals can be infected with cholera, I made inquiries everywhere in India whether similar diseases had ever been remarked in India among animals. In Bengal I was assured such a phenomenon had never occurred. This province is extremely thickly populated, and there are many kinds of animals there which live together with human beings. One would suppose, then, that in this country, where cholera exists in all parts of it continuously, animals must often receive into their digestive canal the infectious matter of cholera, and indeed, in just as effective a form as human beings, but no case of an animal having an attack of cholera has ever been observed there. Hence I think that all the animals on which we can make experiments, and all those, too, which come into contact with human beings, are not liable to cholera, and that a real cholera process cannot be artificially produced in them. We must, therefore, dispense with them as a material for affording proofs.

But with this I do not by any means intend to say that no proof at all can be brought of the pathogenic action of comma-bacilli. I have already explained to you that, for my own part, I can form no other idea, even without these experiments on animals, than that a causal connection exists between the comma-bacilli and the cholera process. Should it prove possible later on to produce anything similar to cholera in animals, that would not, for me, prove anything more than the facts which we now have before us. Besides, we know of other diseases which cannot be transferred to animals, *e.g.*, leprosy; and yet we must admit, from all that we know of leprosy-bacilli, that they are the cause of the disease. For this disease, also, we must dispense with experiments on animals, because as yet no species of animals has been found susceptible to leprosy. It is probably the same with enteric fever; I do not know that any one has ever succeeded in infecting animals with it. We must be satisfied with the fact, that we verify the constant presence of a particular kind of bacteria in the disease in question, and the absence of the same bacteria in other diseases. The bacteria in question must always coincide exactly with the infectious principle of this particular disease, and to this point I attach great value; the presence of pathogenic bacteria must be one corresponding to the pathological transformations in the body, and to the course of the disease. On the other hand, we know of diseases of animals, also, which cannot be transferred to human beings; for example, rinderpest and pneumonia of cattle. We meet here with a phenomenon widely spread in nature.

Almost all parasites are restricted to only one or very few species of animals, which act as their host. I remind you of tapeworms; many kinds of animals have their own special tapeworm, which can only develop in one species of animal, and in no other.

We must, therefore, dispense with this part of the proof in a large number of infectious diseases, which number also includes the exanthematic diseases; and we can do this the more readily, because we already know a whole series of other diseases, which are caused by pathogenic organisms, in which, however the conditions in other respects are the same, and of which we know with perfect certainty that the disease is occasioned by the micro-organisms belonging to these diseases while we have never yet seen that the disease produces a specific micro-organism. I think that, after having become acquainted with a whole series of such diseases caused by micro-parasites, we are justified in drawing an analogous conclusion.

But, further, some observations are before us which are as good as experiments on human beings. We can look upon them as complete experiments which have taken place under natural conditions. The most important of these observations is the infection of those persons who are occupied in handling cholera linen. I have often had an opportunity of examining cholera-linen and have always found the comma-bacilli in enormous numbers, and generally in a regular pure cultivation, in the mucous substance which is found on the surface of the linen soiled by the dejecta.

If, therefore, an infection can be brought about by cholera linen, then, as the comma-bacilli are the only micro-organisms in question, it can only be brought about by them. Whether the transmission was brought about by the laundress bringing her hands soiled with comma-bacilli into contact with her food or directly with her mouth, or by the water that contained bacilli splashing and some drops of it reaching the lips or mouth of the laundress, in any case the conditions are the same here as in an experiment in which a human being is fed with a small quantity of a pure cultivation of comma-bacilli. It is indeed an experiment which a human being unconsciously performs on himself, and the same demonstrative power lies in it as if it had been intentionally made. This observation has furthermore been frequently made and by very various medical men, so that there can be absolutely no doubt of their trustworthiness. I can, besides, appeal to an observation of my own on this point. I succeeded in finding comma-bacilli with all their characteristic peculiarities in a tank that supplies water for drinking and household purposes for all the people living around. in the immediate neighborhood of which a number of fatal cases of cholera had taken place. It was later shown that the linen of the first person that had died of cholera in the neighborhood of this tank had been washed in the tank. That is the only time that I have as yet been able to find the comma-bacilli outside the human body. On the bank of this tank there were 30 or 40 huts, in which from 200 to 300 people lived; and 17 of these had died of cholera. It could not be ascertained exactly how many had been taken ill. Such a tank supplies those who live close to it with water for drinking and household purposes; but at the same time it receives all the refuse from the houses. The Hindoos bathe in it every day, they wash their utensils in it, the human fæces are by preference deposited on its banks, and when a hut is provided with a cesspool it drains into the tank. This was precisely the case with the tank in question. When the comma-bacilli were first found in tolerably large numbers and at different points of the bank, the small epidemic had already reached its maximum. A short time afterward when only isolated cases occurred the comma-bacilli were only to be found at one spot, and in small numbers. When they were first found, they were so abundant that their number could not have depended alone on the dejecta that had flowed into the tank and on the wash water from cholera linen; an increase of them must have taken place. On the second investigation, on the other hand, their small number did not correspond to the numerous cases of illness that had preceded. If the latter had supplied the tank water with bacilli, the bacilli must have been far more numerous this time, in comparison with the first time they were discovered. Hence it cannot be said in this case that the presence of the comma-bacilli in the tank was only a consequence of the cholera epidemic. The relation was such that the epidemic must have been a consequence of the bacilli. We must lay the greater value on observations of this kind, especially on the infection through cholera linen, because we shall perhaps never be in a position to make direct successful infection-experiments with comma-bacilli.

The fact that the etiology of cholera, so far as it is known to us, agrees completely with the peculiarities of comma-bacilli is, I consider, an essential support of my theory that these microbes are the cause of cholera.

We have seen that comma-bacilli grow very rapidly; that their vegetation quickly reaches its maximum, then ceases; and that the bacilli are finally driven away by other bacteria. This corresponds exactly to what takes place in the intestines.

It can be assumed that, just as in the case of other bacteria, very few individuals are sufficient—under certain circumstances, one single one—to cause infection. Accordingly, we can very well imagine that individual comma-bacilli reach the intestinal canal accidentally, and speedily multiply there. As soon as they have multiplied to a certain degree, they occasion a state of irritation of the mucous membrane of the intestine and diarrhœa: but when the multiplication continues in increasing progression, and reaches the maximum point, then there occurs a culmination into the peculiar complex of symptoms that we characterize as the real attack of cholera.

We have already seen that comma-bacilli most probably, under certain conditions, cannot pass the stomach, at least in animals. This also agrees with all experience of cholera, for predisposition seems to play an important part in cholera infection. It can be assumed that, of a number of people exposed to cholera infection, only a fraction of them fall ill, and these are almost always those already suffering from some kind of digestive disturbance, *e. g.*, catarrh of the stomach or intestines, or those who have overloaded the stomach with indigestible food. Especially in the latter case, more or less undigested masses of food may pass into the intestinal canal, and possibly bring with them the comma-bacilli not yet killed in the stomach. You have doubtless often observed that the greater number of cases of cholera occur on Mondays and Tuesdays—that is, on the days which have generally been preceded by excesses in eating and drinking.

It is certainly a strange phenomenon, that comma-bacilli confine themselves to the intestines. They do not pass into the blood, nor even into the mesenteric glands. How is it now that this bacterial vegetation in the intestine can kill a man? In order to explain this Koch calls attention to the fact that bacteria, when they grow, not only consume materials, but also produce substances of very various kinds. We know a great many products of the vital action of bacteria, which are of a very peculiar nature. Many of them are of a transient nature, and emit an intense smell; others produce coloring matter, others poisonous substances. In the putrefaction of albuminous liquids, *e. g.*, blood, poisons are formed which must be products of vital changes of these bacteria, as putrefaction is only a consequence of the growth of bacteria. Many phenomena go to show that these poisons are only produced by special kinds of bacteria, for we see that putrefying fluids can at times be injected into an animal without producing any effect, whereas at other times they prove decidedly poisonous. In this light, I picture to myself the effect of comma-bacilli in the intestine, which depends upon the products of vital changes. In favor of this view, I possess special points of support. It so happened that in one cultivation experiment, the nutritive gelatine contained at the same time blood corpuscles in tolerably large numbers and comma-bacilli. After this gelatine had been poured upon a plate, a number of colonies of comma-bacili grew. The plate looked as if a reddish dust were suspended in it, as, when the light fell through it, one had a clear impression of the single blood-corpuscles. In this reddish, finely granular layer, the colonies of comma-bacilli looked to the naked eye like small colorless holes. When they were examined under the microscope, the striking phenomenon was discovered that the colonies of comma-bacilli had destroyed all the blood-corpuscles within a pretty wide circle, and also to some distance beyond the limit within which they had liquefied the gelatine. From this it is seen that comma-bacilli can exercise a destructive influence on the formed elements of the blood, and very probably also on other cells.

Mr. Richards, a medical man at Goalundo, in India, has also made an observation which supports the view of the presence of a poisonous substance in the contents of the cholera intestine. Mr. Richards fed some dogs with large quantities of cholera dejecta, without producing any effect on the dogs. Then he made the same experiment with pigs, which, according to his statement, died in cramps a very short time (from a quarter of an hour to two hours and a half) after being fed. This was clearly a case of poisoning, and not, as Mr. Richards supposes, of artificial cholera infection. That this was really so, is especially seen from one of the experiments, in which the contents of the intestine of a pig, killed by being fed on cholera dejecta, which, according to Mr. Richards' opinion, had the cholera, were given to another pig. This second pig did not suffer from it, so that a reproduction of the supposed infectious matter in the intestine of the pig fed first could not have taken place. If genuine cholera could be produced among pigs, it would then be possible to infect a second pig with the contents of the intestine of the first, and a third with those from the second, and so on. Although these experiments do not prove what Mr. Richards intended to prove by them, they are interesting, in so far as they show that, in cholera-dejecta, substances can under certain circumstances be contained, which are poisonous to pigs. Dogs seem to be unaffected by them; mice and other animals also, as our experiments showed. The power of resistance of other animals to this poison, and the susceptibility of pigs to it, ought to cause no surprise, when we remember that only pigs seem to be killed by the poison which sometimes forms in the brine of salt meat and herrings.

Supposing that comma-bacilli produce a special poison, the phenomena and course of cholera can be explained as follows: The effect of the poison shows itself partly in an immediate manner, the epithelium, and in the worst cases also the upper layers of the mucous membrane of the intestine, being mortified thereby; it is partly reabsorbed and acts on the organism as a whole, but especially on the organs of circulation, which are as it were paralyzed. The complex of symptoms of the attack proper of cholera, which is generally looked upon as a consequence of loss of water and the inspissation of the blood, is, according to my opinion, to be regarded essentially as poisoning; for it takes place not infrequently when comparatively very small quantities of fluid are lost during life by vomiting and diarrhœa, and when, immediately after death, the intestine also contains only a small quantity of liquid.

If, now, death follow in the stage of cholera poisoning, then the phenomena met with in *post-mortem* examinations correspond to those cases in which the mucous membrane of the intestine is little changed, and the contents of the intestine consist of a pure cultivation of comma-bacilli. If, on the contrary, this stage be prolonged, or if it be got over, the consequences of the mortification of the epithelium and of the mucous membrane show themselves; capillary hemorrhage in the mucous membrane takes place, and some of the component parts of the blood mix in more or less abundance with the contents of the intestine. The albuminous fluid in the intestine begins to putrefy, and, under the influence of the putrefaction-bacteria, other poisonous products are formed which are also absorbed. But these have an effect differing from that of the cholera poison; the symptoms caused by them correspond to what is generally called cholera-typhoid.

Corresponding to the view that the comma-bacilli only vegetate and unfold their effect in the intestine, the seat of the infectious matter can only be looked for in the dejecta of patients. Exceptionally, however, they may be found in the vomit. In this, I think I am in accord with the more recent views. It is true that this view is still contradicted by some investigators, but we are in possession of incontrovertible proofs in its favor—above all, infection by means of linen; so that, quite apart from the comma-bacilli, there can be no doubt that the dejecta really contain the infectious matter. For the further spread of the infectious matter, the first condition is that the dejecta remain in a moist condition. As soon as they are dry, they lose their effectual agency.

One of the commonest ways of spreading the infectious material of which, too, we have had an example in the tank epidemic, is water. How easily can cholera-dejecta or water used for cleaning cholera linen get into wells, public water-courses, and other places for the supply of drinking-water and of water for household purposes. Thence the comma-bacilli find plenty of opportunities of returning into the human household, either in drinking-water or in water used for being mixed with milk, for cooking, for rinsing pots and pans, for cleaning vegetables and fruit, for washing, bathing, etc.

Beside these ways, the infectious matter can enter the human digestive organs by a shorter way; for comma-bacilli can, beyond a doubt, retain vitality for a considerable time on articles of food which have a moist surface, and it can easily be supposed that they are not rarely brought thither by being touched with dirty hands; and I do not consider it at all impossible that the infectious matter is transferred to food by means of insects—for example, by common flies. In most cases, certainly, the infectious matter enters the soil with the dejecta, and finds its way, somehow or other, into wells or tanks.

I start with the assumption that only moist substances and those of most different kinds (I do not by any means confine myself to drinking water) that are polluted in any way by moist dejecta, may also convey the infectious matter to the body. On the other hand I do not think that the infectious matter of cholera can keep in a dry state, or, which is the same thing, that it can be transferred by means of the air. For the dispersion of an infectious matter can, as a rule, only take place by means of the air when dry, and in the form of dust. Experience is also in favor of the view that the infectious matter cannot be introduced in a dry state, for we know that hitherto cholera has never come hither by means of goods on the way from India; never as yet have letters or postal packets introduced cholera, even when not, as is now frequently done, pierced through and fumigated. If the origin of the separate epidemics be carefully looked into, it will be found that cholera has never reached us except through human beings themselves; and although people have not succeeded in the case of these separate epidemics in tracing the individual who brought the infectious matter, one must not conclude from this that this is an exception. For we must consider that it is not only the individual who dies of cholera, or who has an unquestionable attack of cholera, that is liable to transfer infection, but that all possible transitions up to this most violent form of the disease, even slight attacks of diarrhœa, take place, which are probably just as capable of giving infection as the worst case of cholera. Of course we can only arrive at positive certainty on this important point when the slightest cases have been proved to be real cases of cholera by detecting the presence of comma-bacilli.

The important question still remains to be answered, whether the infectious material can reproduce or multiply itself outside the human body. I believe that it can. As the comma-bacilli grow on a gelatine plate, as they can grow on a piece of linen, or in meat broth, or on potatoes, they must also be in a position to grow in the open air, especially as we have seen that a comparatively low temperature allows them to develop. I would not certainly assume that the multiplication of the comma-bacilli outside the human body takes place in well water or river water without any assistance, for these fluids do not possess that concentration of nutritious substances which is necessary for the growth of the bacilli. But I can easily imagine that, although the whole mass of the water in a tank or reservoir is too poor in nutritious substances for bacilli to flourish in it, yet some spots may contain sufficient concentration of nutritive substances—for example, those spots where a gutter, or the outlet of a cesspool, opens into the stagnant water, where vegetable matter, animal refuse, etc., lie, and are exposed to putrefaction by bacteria. At such points, a very active form of life can develop.

I have often formerly made such experiments, and it has frequently happened that a specimen of water contained scarcely any bacteria, while remains of plants, especially roots or fruits swimming in it, teemed with bacteria. more particularly bacilli and spirilla. Even in the immediate neighborhood of these objects, the water was rendered turbid by swarms of bacteria, which clearly received their nourishment from the nutritive matter scattered by diffusion at a very small distance.

I think that we can in this way most readily explain the relations of subsoil-water to the spread of cholera. Everywhere where water is stagnant on the surface or in the ground, in marshes, in harbors which have no outflow, in places where the ground is trough-shaped, in very slowly running streams, and such like, the conditions described can develop. There, in the neighborhood of animal and vegetable refuse, concentrated nutritive solutions will be most easily formed, and will give the micro-organisms opportunity for forming colonies and multiplying. On the other hand, wherever the water at the surface as well as at the bottom is in a state of rapid motion, and subject to continuous change, these conditions are less easy, or do not occur at all; for the continuous flow of the water prevents the formation of a local concentration of nutritive substances in the liquid sufficient for pathogenic bacteria. The connection between the falling of subsoil water and the increase of several infectious diseases I would explain as follows. That, when the subsoil water falls, the current that takes place in the subsoil water is much less significant. Besides, the quantities on the surface are much diminished, so that those concentrations, which I assumed to be necessary for the growth of the bacteria, must much sooner take place.

If we assume that a special specific organism is the cause of cholera, we cannot think of an autochthonous origin of the disease, emanating from any particular locality. Such a specific organism, even if it be only a comma-bacillus, follows the laws of vegetation, just as the most highly developed plant. It must always propagate itself from something of the same nature, and cannot spring up at hap-hazard from other things, or from nothing. But, as comma-bacilli do not belong to micro-organisms that are distributed everywhere, we are forced to trace back the disease that depends upon them to special localities from which these specific micro-organisms are brought to us. We cannot, therefore, imagine that, because the delta of the Nile resembles the delta of the Ganges in some points, cholera could spontaneously spring up there by way of exception, as was seriously maintained last year. Just as little reason have we for supposing that cholera should spring up here in Europe without the comma-bacillus having been previously introduced.

Koch then describes the peculiarities of the endemic home of cholera in India, adding that one can easily imagine what quantities of vegetable and animal matter are exposed to putrefaction in the boggy district of the Sunderbunds, and that an opportunity, scarcely to be found in any other place in the world, is offered here for the development of micro-organisms. In this respect, the boundary between the inhabited and uninhabited part of the delta is especially favorable. There the refuse from an exceptionally thickly populated country is floated down by the small streams, and mixes with the brackish water of the Sunderbunds that flows backward and forward, and is already saturated with putrefied matter. Under peculiar circumstances a thoroughly special fauna and flora of micro-organisms must develop here, to which in all probability the comma-bacillus belongs.

Koch then proceeds to show that the comma-bacillus finds in the nature of the territory described, in the climate, in the manner of native hut-building, and in the habits of the people, so many factors that favor its permanent habitat in that part of India. He then alludes to the good effects of sanitation and especially the improvement of the water by the establishment of drains and similar hygienic measures.

As a good illustration he describes the condition of things in Calcutta before and after the time of the establishment of water-works. But the influence of obtaining good water, he finds, has been more plainly shown at Fort William, where cholera disappeared altogether after the garrison received a reliable water supply.

On the other hand, Koch distinctly states that he is not a supporter of the exclusive drinking-water theory. The ways in which cholera can spread in a given locality are extremely diverse. He holds that every place has its own peculiar conditions, which must be carefully studied and protective measures instituted in accordance therewith. In India the spread of cholera clearly depends upon human intercourse, the pilgrimages being largely responsible for its wide dissemination.

Regarding cholera on ships, he points out that real epidemics only take place when a large number of people are on board.

On one question of cholera etiology, which is of a more theoretical interest, I have not yet had an opportunity of saying anything. It is a noteworthy fact, that outside of India cholera always dies out after a comparatively short space of time. This disappearance of the plague seems to me to be due to a variety of factors.

In the first place, I consider it established that the individual, as in many other infectious diseases, after having once had cholera, acquires a certain immunity. This immunity does not seem to be of very long duration, for we have examples enough that a man who was attacked during an epidemic caught the cholera again in a second epidemic; but one seldom hears of a man being attacked twice during the same epidemic. But precisely in cholera several attacks ought to occur, because a man who has got over the attack, as a rule, returns after a few days to the same conditions, and exposes himself to the same dangers and the same source of infection. Some experiences made in India, moreover, are in favor of the view that a certain immunity is obtained after recovery from an attack of cholera. In the same manner as an individual can obtain immunity, so can whole localities, as a good deal of experience proves, become more or less free from cholera for a certain period. It is often seen that when a place has been attacked by cholera, and been thoroughly infected by it, this place is spared the next year, or it only suffers slightly when the cholera returns.

As a second reason for the extinction of a cholera epidemic, we must take the absence of a permanent state, capable of assisting the infectious material in surviving the period of the immunity of the population that is unfavorable to its development.

Finally, we must take note of the circumstance that temperatures under 62.6°

Fahr. have such an unfavorable effect on the growth of the bacilli outside the body, that their multiplication can no longer take place. When all these factors work together; when winter comes on, and only a population remains which is more or less non-liable to the epidemic, then it must die out, as the infectious matter possesses no permanent state.

Before I conclude, I should like to add a few words as to how we can utilize the discovery of the comma-bacilli. The cry we commonly hear is—Yes, but what is the use of this discovery to us? We certainly know that the cholera is caused by comma-bacilli, but, nevertheless, we are in no better position for curing this disease than before. I remember that these were often the expressions used about the discovery of tubercle-bacilli.

Anybody who looks upon these matters from the point of view of the medical man who has to write a prescription, is certainly right in saying that he has as yet no perceptible utility before him; but these critics ought to consider that rational therapeutics for the majority of diseases, and especially for infectious diseases, cannot be obtained till we have found out their causes and nature. But, apart from this, I imagine we already have a very considerable advantage from the discovery of the comma-bacillus. I think, first, of how we can utilize it in a diagnostic direction. It is highly important that a correct diagnosis should be taken of the first cases which occur in a country or locality. According to my view, by showing the presence or absence of cholera-bacilli, we can say with certainty whether we have cholera before us or not. This seems to me to be a very essential advantage.

I further think that, after having become acquainted with the real cause of the disease and its qualities, the etiology of cholera can be constructed on definite and fixed lines, and that we shall at length get rid of many contradictions. We shall now obtain a firm basis for a uniform action that knows the end at which it is aiming. I anticipate special advantages from the observation that comma-bacilli are killed by being dried.

But, above all, we can deduce this advantage, that an end will at length be put to the fearful squandering of disinfectants, and that millions will not again, as in the last epidemics, be poured into gutters and cesspools without the slightest advantage.

For the rest, I hope that the recognition of the comma-bacilli can be turned to account therapeutically. We shall be able in future, even in the less severe cases, and in the first stages, to make a diagnosis. In accordance with this, therapeutic experiments, also, will have more certainty when it is known that the patient is really suffering from cholera. An early diagnosis must, however, be of all the greater value, as the chance of therapeutic success is precisely greatest in the first stages.

It is beyond the scope of this volume to give a detailed account of the interesting and important discussion that followed the reading of Koch's elaborate address. But in order to indicate its nature and acquaint the reader with the general drift of opinion elicited during the debate, the questions submitted for consideration by Koch are here reproduced with this comment, that the answers, in the main, fully harmonized with Koch's personal views.

The questions discussed were the following:

Is cholera caused by an infectious material, originating only in India?

Is the infectious material contained only in the dejections, and later also in the vomited matters, or is it found also in the blood, urine, sweat and breath?

Has the finding of comma-bacilli any diagnostic importance?

Is the infectious material of cholera identical with the comma-bacilli?

Has this infectious material much power of resistance and a condition of permanency? And is it destroyed in a short time by drying?

Can the infectious material enter the body through any other channels than the digestive tract?

Is the infectious material reproduced within the body, or does this occur in the ground, man and animals merely acting as carriers?

Is a direct transplantation possible, or must the infectious material undergo some sort of ripening or modification in the ground or elsewhere?

Is a special individual predisposition necessary for the action of the infectious material? What is the duration of the period of incubation? Does one attack confer immunity for a certain length of time? Can the *modus operandi* of the bacilli be interpreted as an intoxication?

CHAPTER XXII.

OTHER RECENT RESEARCHES ON CHOLERA.

HAVING presented an accurate and complete statement of Koch's doctrine in the last chapter, we may now profitably turn our attention to the recent investigations into the nature of cholera carried on by others, working independently of the German inquirer.

An examination of these recent researches will, among other things, serve to bring out the controversial issues raised since the announcement of his doctrine by Koch. Mere polemics will be avoided as much as possible. The arguments of those who completely oppose Koch will, of course, receive the same impartial consideration extended to the views of the writers who uphold him.

During the epidemic at Toulon, Straus and Roux continued certain researches, begun in 1883 in Egypt together with Thuillier and Nocard. In their report to the Paris Academy of Medicine they say that they do not believe Koch's comma-bacillus to be the specific microbe of Asiatic cholera. It has, they assert,

> been observed in other diseases, and cholera has not been provoked in animals by inoculations of this bacillus. Dr. Straus maintained that the researches made at Toulon confirmed the results of those made in Egypt. There they detected the presence of micro-organisms in the intestinal mucous membrane, especially when the attack was prolonged, and the intestines presented minute patches of hemorrhage. In three cases of cholera where the patients were struck down in ten or twenty hours, the intestines at the autopsy were found not congested. On the contrary they were paler than normal. It was also impossible to detect the presence of a micro-organism. In another, a very severe case, it was necessary to make a considerable number of preparations in order to find a few bacilli. Some of the sections, colored by methyl blue, made from fragments of the small intestines, which were previously hardened in alcohol, exhibited micro-organisms in the superficial parts of the mucous membrane of the ducts of the tubular glands, and in the basement membrane of the villi. These micro-organisms varied in number according to the time the attack had lasted. Bacilli were more abundant than other organisms. They varied greatly, both in aspect and in dimension. Some were long and thin, others short and broad. The variety most frequently observed resembled the bacillus of tuberculosis. In some parts this bacillus predominated, and penetrated as far as the submucous membrane, but never entered the blood-vessels nor the muscular coat of the intestines. Other forms of bacilli and micrococci were also present in the substance of the mucous membrane. This entero-mycosis was especially evident in the lower portion of the small intestine. Straus and his colleagues did not consider that these data furnished conclusive evidence concerning the origin of cholera.
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> Straus also draws attention to the fact that, during life, the intestinal mucous membrane of cholera patients loses its epithelium, and therefore may be easily invaded by the organisms present in the surrounding fluids. He suggests a secondary invasion of the intestine by microbes. Straus and Roux state further that the rice-water stools of cholera patients also con-

tain micro-organisms. Among these the comma form is frequently seen. This micro-organism is found almost isolated in the intestinal mucus. They do not consider that proof of its specificity is obtained until cholera is provoked in animals inoculated with a perfectly pure cultivation. Moreover, the comma-bacillis is not special to cholera. Dr. Maddox, of London, has photographed a micro-organism found in a water cistern, presenting the form of a comma. Malassez has detected it in the stools of dysenteric patients, among many other varieties. Straus and Roux also observed it in the vaginal mucus of women suffering from leucorrhœa, and in the uterine secretion of a woman affected with epithelioma of the cervix uteri. In their report on the cholera epidemic in Egypt, the authors indicated in the blood of cholera patients the presence of excessively small, thin particles, presenting the aspect of organisms. At Toulon, the same phenomena were observed in the course of their researches, though not always. They supposed these corpuscles to be due to a special alteration of hæmoglobin.

It will be remembered that Koch in his address alluded to this matter, saying that Straus had been unable to demonstrate to him the alleged organisms of cholera blood.[1]

The Marseilles epidemic of last year naturally became the occasion of much medical research, directed toward the elucidation of various cholera problems.

The first investigators to publish an account of their doings were M. Magnon, Professor of Natural Sciences at the Lyceum, and M. Cognard, who was delegated by the Medical Society of Lyons to study on the spot the disease in all its bearings.[2] These gentlemen directed their researches especially to the question of the transmissibility of cholera from man to the lower animals. In order to render their experiments as conclusive as possible they employed various modes of procedure and made use of several different varieties of animals. But in no case was any positive result obtained. In a preliminary report made by M. Cognard prior to his departure from Marseilles, he stated that the experiments were undertaken from a conviction that the only means of arriving at any positive conclusions concerning the infectious agent of cholera, which might serve as a basis for a rational therapy, was by inoculating the lower animals. With this object they injected into the veins filtered choleraic discharges and also atmospheric water from the wards of the Pharo hospital, obtained from the moisture collecting in the sides of a jar filled with cold water. They likewise injected a Pravaz syringeful of cholera dejections containing microbes, especially comma-bacilli, into the trachea of a monkey and into the cellular tissues of a cat. But their most common mode of procedure, and one which they claim they were the first to employ, was to expose a loop of the small intestine through an incision made in the linea alba, and, after incising this, to inject a large syringeful of the cholera dejections. The intestine was then sutured and returned into the abdominal cavity and finally the external wound was closed. The animals experimented upon were cats, monkeys, a dog, a large white rat and a jackal. Not one of them died of cholera. Only two of the animals died, death in both instances being due to peritonitis and not cholera. Magnon and Cognard concluded, therefore, that for this epidemic at least, the lower animals were not susceptible to the action of the cholera poison.[3]

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[1] The reader is also referred to the section on Morbid Anatomy, where will be found a quite recent retraction by Straus of the claim concerning the occurrence of micro-organisms in the blood of cholera patients.

[2] Étude historique et pratique sur la prophylaxie et le traitement du choléra. Par le Dr. H. Mireur, Paris and Marseilles, 1884.

[3] Repeated attempts have been made years ago by Thiersch and others, to cause

The National Medical Society of Marseilles appointed a commission to study the cholera during the epidemic of 1884, consisting of MM. A. Sicard, Taxis, Bouisson, Queirel, Poucel, Livon and Chareyre. In their official report[1] they deem it necessary to state that their investigations were begun without prejudice or inclination to any particular theory. There were two views which demanded their special attention by reason of the high reputation and the scientific attainments of their respective French and German upholders. For this reason they devoted their time chiefly to the study and examination of the intestinal contents and of the blood. The first thing that attracted their attention was that there was always an inverse relation between the number of comma-bacilli and the degree of coloration of the stools, the rice-water discharges containing the microbes in greatest abundance. Every conceivable effort was made to transmit cholera to the lower animals, vomited matters and the intestinal contents, filtered and not filtered, were injected in various ways into the trachea, stomach, small and large intestine, peritoneal cavity, and blood-vessels, but in no case were any signs, either clinical or pathological, of cholera observed. Yet in a rabbit, dying eleven days after such an injection into the small intestine, without a sign of cholera, numbers of comma-bacilli were found in the gut, showing that the soil was at least favorable to their preservation. The injection of fresh matters having failed, a rice-water stool, consisting of almost a pure culture of the comma-bacillus, was obtained. Some pieces of linen were now soaked in this fluid and preserved moist for some time. Inoculations made with the washings of these rags, at the end of three and again of nine days, gave negative results. The animals used in these experiments were rabbits, dogs and guinea-pigs.

As Koch had stated that water was liable to contamination by the cholera bacilli, an examination was made of water taken from a faucet in their laboratory and from the Rose near its source. For its examination they used the method described by Koch, and found that the water taken from the Rose contained on an average ten comma-bacilli in every drop or 250,000 in every litre. A power of 600 diameters was used, and the bacilli found were identical in size, appearance and mode of staining with those described by Koch.

The investigators next turned their attention to the blood, and first to the bodies described by Straus. But they soon found that these little bodies were present in healthy individuals as well as in the sick. Other varieties of micro-organisms were found in the circulating fluid, but none which by their constancy could be regarded as characteristic. They found, however, an alteration in the red blood-corpuscles which they regarded as of great importance. The change did not affect all the globules at once, for often corpuscles profoundly altered were seen by the

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cholera in the lower animals, either by feeding them with matter passed from the bowel or vomited by cholera patients. They have been quite recently repeated, and additional experiments have been instituted by injecting pure cultures into the veins or subcutaneously. But most of these experiments have been entirely without result. Such inoculations, in order to be successful, must be practiced upon animals which are susceptible to the poison of cholera. It was formerly believed that many species of animals were subject to attacks of Asiatic cholera, but modern veterinarians have denied that this is the case. See also the account of Van Ermengem's most recent investigations, which invariably gave positive results when guinea-pigs were employed.

[1] Recherches sur le choléra. Rapport lu au nom de la Commission, etc. Marseilles, 1884.

side of perfectly healthy ones. This alteration, they stated, consists in a softening of the corpuscles, whence results a change of shape from mutual pressure, and an agglutination of numbers of the globules in masses of greater size as the disease is more advanced. If a current becomes established in the field of observation, these diseased globules are seen flowing along like lava or melted tar between the more compact masses. Sometimes the corpuscles are seen to become elongated, olive-shaped, or even almost cylindrical through the action of the current; sometimes they are torn away from the mass, and then owing to their elasticity they frequently return to their normal shape. But in the graver cases of the disease the corpuscles seem to have lost this elasticity and maintain their oval shape even when entirely separated from the neighboring corpuscles. If artificial serum be added during the microscopical examination, most of the red globules may be seen to resume their proper shape, to become detached from the sticky mass, and to arrange themselves in the normal way like rolls of coin; but where the alterations are most profound this separation does not occur. This change in the blood was found in every case, and the commission stated that they were disposed to regard it as characteristic, as "the pathognomonic lesion of cholera."

Several experiments were undertaken to determine the power of this altered blood to transmit cholera to the lower animals, but they were not conclusive. Two rabbits, upon which injections were practiced with blood taken from a subject dead at the beginning of the algid stage, died at the expiration of eighteen hours, presenting lesions "which we should be inclined to regard as belonging to cholera" and the hæmatic changes above described. Two other rabbits injected with blood taken from a living subject at the beginning of the cold stage had diarrhœa with colored stools the following day, and in one of them there were seen masses of agglutinated red blood-globules. A dog injected with blood taken from a subject dead in the algid stage suffered for two days from a serous diarrhœa. All the remaining experiments, to the number of twenty-five, made with blood taken during a prolonged algid stage or in the period of reaction, gave negative results. The blood used in the first experiment, kept at a temperature of 100° F. in air filtered through cotton, speedily lost its virulence.

The conclusions drawn by this commission from their researches were that: 1. Cholera may be transmitted to the lower animals; 2. The contents of the stomach and intestines and even the pure rice-water discharges are absolutely inoffensive; 3. The same is true of blood taken during the period of reaction, and it is only in the algid stage that it possesses an infectious property; 4. This property is the more marked the nearer to the beginning of the cold stage the blood is taken; and it disappears within, at the most, twenty-four hours after the blood is drawn, and probably in a much shorter time. They state further that their investigations force them to regard the German theory as merely an hypothesis which is not supported by a single experiment and which receives a new refutation in the mode of propagation of cholera. They confessed, however, that although "we have shown the toxic action of the blood in the algid stage, we have been unable to discover in it any specific agent."

They likewise are forced to admit that the result of their investigations enables them to say "what cholera is not, rather than what cholera is."

We come next to a communication made to the Semaine Médicale[1] by

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[1] Semaine Médicale, No. 38, 1884.

Drs. Nicati and Rietsch in which they give a *resumé* of the experiments conducted by them up to that time. They state that when the intestinal contents of a person dead of cholera, or an artificial culture of comma-bacilli, is injected into the duodenum of a dog, after ligature of the ductus choledochus, the animal dies after one or several days, and its intestine, like that of a person dying after suffering from cholera for some hours, is found filled with a thick milky fluid very rich in epithelial cells. The comma-bacilli are found there in abundance after the material has been exposed to moist air for a length of time varying with the temperature. It has been objected that the ligature of the common duct is alone sufficient to cause death, but the authors assert that even when this happens it does not by any means rapidly follow the operation. Cats have survived the operation from one to nineteen days, and guinea-pigs from three to twenty-eight days. These animals at one commence to eat and soon regain their usual strength. It is only some days afterward that they begin to emaciate, and they finally die after having lost considerable weight. The same lesions as those observed in the dogs were seen in guinea-pigs, after an injection into the duodenum without previous ligature of the choledoch duct, and even after the introduction of a large quantity of the virulent material into the stomach by means of a catheter. The symptoms observed during life were diarrhœa, vomiting (only in dogs), cyanosis and reduction of temperature. In one instance an increase of temperature was observed in a dog after death. An examination of the blood, as in cholera patients in the algid stage, showed no tendency in the red globules to become crenated, but, on the contrary, they became altered in shape by mutual pressure, as occurs when asphyxia is produced by mechanical compression of the trachea.

Starting with the assumption that when an inoculation was without results it was by reason of digestion of the ferment by the gastric or intestinal secretions, MM. Nicati and Rietsch made a study of these various secretions. They found, as stated by Koch, that the gastric juice was very destructive to the comma-bacilli. The pancreatic juice seemed to be without effect. The bile also appeared to exert no deleterious influence upon the comma-bacilli in broth cultures, but certain facts would seem to show that it possessed a different action in the living intestine. In examining choleraic dejections they found several specimens in which the bacilli were exceedingly abundant, where scarcely a trace of bile could be detected by the nitric acid test.

In their recently published monograph,[1] MM. Maurin et Lange claim to have discovered the true micro-organism of cholera. It is a fungus growth consisting of mycelium, filaments and spores, to which they have given the name of *Mucor choleriferus*. This fungus they found to be developed invariably in cholera dejections, after standing four or five days, but in no others. The spores, they state, are constantly floating in the atmosphere of an infected district, and thence gain ready access to the human organism. When taken into a healthy stomach they are difficult of digestion and give rise to a painful tension of this organ, so commonly observed during an epidemic of cholera. But if indigestion be present and the stomach contain acescent or putrescent matters, the spores germinate and produce long chains. This is similar to what occurs when mucor racemosus attacks acid wine. These chains act like ferments absorbing oxygen, water and heat, and to their vegetation are due all the phenomena of cholera.

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[1] Mucor Cholérifère, Organisme de Transmission du Choléra. Paris: Felix Alcan, 1885.

In acetic fermentation, after the mycoderma has produced its effect, spirilla make their appearance. And precisely in the same way in choleraic fermentation after the chain plants, developed from the spores of the mucor, have produced their effects, the vibrio virgula of Pacini (now better known under the name of Koch's bacillus) appears upon the scene. But the comma-bacillus is not the cause of the choleraic fermentation; it is only developed secondarily because it finds there a favorable soil. That is the reason why, in rapidly fatal cases (*cas foudroyants*) no bacilli are found. "The bacillus of Koch is an epiphenomenon of the choleraic fermentation." The organism of transmission of the disease is indeed contained in the intestine of the cholera patient, but in order to become active it must be incubated for a certain length of time in the open air. That is why cholera is not immediately contagious, and why the stools are one of the active and real agents of the secondary contagion which creates epidemic centers.

Comment upon this publication, which was heralded in France as a great discovery, is hardly called for. The plan of procedure adopted by Maurin and Lange is found to be so crude, when examined in the light of the exact experimental methods of modern inquiries, that it is unnecessary to further emphasize that their observations are certain to remain sterile.

CHAPTER XXIII.

THE CHOLERA-BACILLUS CONTROVERSY—KOCH'S DISCOVERY CONFIRMED.

The investigations described in the last chapter indicate a laudable zeal to ascertain the nature of cholera, and have in a measure extended our knowledge of the disease. Koch's views, it was seen, were by no means accepted by all these French experimenters. It seems proper in the next place to briefly refer to some of the more direct criticisms called forth by the German's announcement of the discovery of the specific microbe of cholera. Now in the opinion of the editor it is a rather deplorable fact that those who were from the first disinclined to accept Koch's conclusions have busied themselves much more with finding evidence that might overthrow his doctrine, than with prosecuting independent inquiries calculated to shed additional light on the obscure points of the disease.

Of course Koch from the first found many ardent supporters. But repeated negation on one side, with affirmation and reiteration on the other, has at length resulted in a bitter and determined cholera-bacillus war. At the present writing the contest still continues, and for the sake of pure science, it is much to be regretted that latterly personal and national feelings have been imported into the strife.[1] That this is detrimental to the advancement of scientific knowledge goes without saying.

It may be worth while to remember that not long ago we were in the midst of a tubercle-bacillus war. In the Medical Press and Circular, December 31, 1884, the following comment thereon is made (with more particular reference to Allgemeine Wiener Med. Zeitung).

> The plan of attack adopted seems mainly that of searching out every scientist or pseudo-scientist who writes against Koch. When one is found he is immediately discovered and pronounced to be a great authority, before whom Koch must of necessity lower his colors. It will easily be foreseen that a warfare such as this could only have one ending, viz., the entire demolition of the bacillus and its discoverer. This result has been achieved many times, and yet, curious to relate, nearly all the leading pathologists in Germany, as well as those of France and our own country, have completely accepted Koch's views as correct and have worked on them for a considerable period, with the result that their opinions as to their correctness have been strengthened.

It is too early in the cholera-bacillus war now to predict its ending. But all impartial witnesses must see the strength of Koch's position. As was pointed out by a leading medical journal in a recent editorial notice, "Koch's doctrine has the great advantage of being positive, plausible, aided by analogy and circumstantial evidence, and, further, supported by the accumulating evidence of independent investigations."[1]

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[1] See for example the ill-advised and intensely personal attack of Professor Ray Lankester upon Koch, published in the Pall Mall Gazette, for October 6, 1884.

Now we have no intention of presenting to the reader a detailed account of the heated controversy concerning the significance of the comma-bacillus. Nevertheless, as already stated, some of the more important objections to Koch's views will have to occupy our attention, on account of the wide currency they have obtained, and because it is supposed by some that the parasitic doctrine has through their universal acceptance received its well-earned death-blow. The fact that most of the French observers do not admit the binding force of Koch's arguments has already been noticed.

Among English writers the first and foremost to raise objections against the acceptance of Koch's bacillus doctrine was Dr. Lewis. In the Lancet of September 20th, 1884, he stated that comma-like bacilli, identical in size, form and in their reaction with aniline dyes, with those found in choleraic dejections, were ordinarily present in the mouth of perfectly healthy persons.[2]

At the annual meeting for 1884, of the Association of German Naturalists and Physicians, a communication was made by Prof. Finkler and Dr. Prior, of Bonn, to the effect that they had found in cholera nostras a micro-organism whose shape was identical with that of the comma-bacillus of Asiatic cholera. Its biological qualities, when cultivated, were regarded as absolutely the same as those of the comma-bacillus described by Koch. They claimed to have discovered evidence of a spore-formation in the comma-bacilli of cholera nostras which had not been established in like manner for the bacilli of Asiatic cholera. Klamann stated at the same meeting that he also had found in cholera nostras organisms exactly like those shown. The statements of Finkler and Prior were, however, criticised on the spot by Hueppe, formerly a worker in Koch's laboratory. He called attention to the differences in the appearance of the comma-bacilli of Koch and of those shown by Finkler and Prior. He also said that the cultivations of these observers were probably impure, as their statements concerning the development of the bacilli did not at all harmonize with those of Koch, whose investigations had continued over a much longer period of time.

Koch's reply to these, the most important criticisms that had appeared until that time, was published on November 6th, in the Deutsche Medicinische Wochenschrift.

It is unnecessary here to follow him in his demonstration of the errors into which the above observers had fallen. Suffice it to say that not by the weight of authority, but from the stress of facts, his position was pretty generally recognized to be stronger than ever.

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[1] The Medical Record, February 28, 1885.

[2] In the Deutsche Med. Wochenschrift (November 27, 1884), W. D. Miller claims that in 1882 he described the curved bacilli in the buccal mucus to which Dr. Lewis has drawn attention as identical with the comma-bacillus. He also contributes further particulars concerning the various bacterial organisms found in this region and in the alimentary canal. The curved bacilli and spirochæte forms he has been unable to cultivate in various media, and therefore they do not resemble in all respects the comma-bacillus. Another organism is one which occurs in the form of short plump rods, often in pairs, and it grows rapidly in gelatine. Another variety is curved, and by the conjunction of two or more individuals produces S-shaped or circular forms. This organism never produces spores, and grows very slowly in gelatine.

Take for a single example the following editorial comment from the Philadelphia Medical News, of November 29th, 1884:

> Koch has two great qualities as an investigator—unequaled *technique* and powers of patient observation. His experience has been vast, and each piece of work which he has done has been remarkable in leaving but little to correct, either by himself or by subsequent observers. No writer on mycology is more reliable; not one has proved himself worthier of professional confidence.

And again,

> These latest observations of Koch afford additional strong confirmatory evidence of the correctness or his views concerning the etiology of cholera and its connection with the comma-bacillus.

In this connection allusion must also be made to the conclusions of Ceci and Klebs, who studied cholera at Genoa. In a preliminary report[1] these authors formulated twelve propositions, the pith of which amounts to the assertion that the commas and spirilla of Asiatic cholera looked precisely like those found by Prior and Finkler in cholera nostras. Klebs also claimed to have discovered commas in the diarrhœal discharges of a patient having pneumonia.

But in a more recent publication by Klebs,[2] he admits that a differential diagnosis between Asiatic and simple cholera is possible by the aid of Koch's comma-bacillus. But he does not believe that it is always an easy matter to differentiate between the two. For the positive recognition of cholera spirilla, he asserts that the culture method is indispensable.

And Ceci, after more extended experimental experience, has even come to the conclusion that the comma-bacilli of Koch are positively causative of cholera.[3] His injections of pure cultures into the intestines of guinea-pigs invariably killed those animals after symptoms of true cholera had been observed. Post-mortem examinations showed characteristic lesions, and in the rice-water contents of the intestines countless commas were found. Ceci is of opinion that the symptoms of cholera are of reflex nervous origin, the primary irritation being produced by mechanical or chemical action of the bacilli in the intestines.

In place of giving a detailed account of the heated war of words that has been waged between the Finklerites and those who support Koch, we merely refer to Fig. 8 (p. 179), which distinctly shows the difference in mode of growth, between the Finkler microbe and the true comma-bacillus.

A number of Italian writers have also published adverse criticisms upon Koch and his doctrine. As an example of the kind of argumentation freely indulged in, we may quite briefly allude to the polemic of Dr. M. Venturoli, who has written a little pamphlet,[4] in which he endeavors to show that the bacillar theory of the German savant is utterly without foundation. He says that the comma-bacillus is not always present in the choleraic discharges, but admits that it is found in cultures. And he, therefore, warns not only Koch, but more particularly his own countrymen, that they ought to go very slowly in describing things the existence of which is as doubtful as that of the cholera microbe.

Turning for a moment to another phase of the cholera-bacillus controversy, what shall be said of the foolhardy experiment of Bochefontaine, who, it will be remembered, swallowed pills made from dejecta of a woman who had died of cholera, in the clinic of Dr. Vulpian.

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[1] Archive per le Scienze Mediche, vol. viii., 4, 1884, p. 415.

[2] Ueber Cholera Asiatica. Basel, 1885.

[3] Sull etiologia del Colera Asiatico. La Riforma Medica, 36 and 37, 1885.

[4] Il Bacillo-virgula di Koch e la Microscopia. Bologna, 1884.

> This fluid contained a prodigious number of vibrionidæ of all kinds and descriptions, among which, however, predominated in point of numbers a kind of very short bacterium which crowded and whirled about the field of the microscope with a rapidity of motion which made it difficult for the eye to follow them. In the midst of this bacteridial mob one could easily recognize the "comma" and "circumflex accent" bacillus. This fluid, injected under the skin of several guinea pigs in the laboratory, killed them in a few hours. M. Bochefontaine, however, beyond "a little fever, nausea, convulsive movement of the legs, dysuria, loss of appetite and constipation," experienced no bad effect, and in twenty-four hours he was all right again.[1]

So, too, what shall be said of Klein, and other bacillus-eaters? Merely that in their zeal to disprove Koch's assertions, they have overlooked an essential part of his doctrine, which assumes that individual predisposition to cholera must exist before the microbes shall become potent for mischief, quite apart from that other circumstance of the destructive action of normal gastric juice upon the vitality of commas. Because ham infected with trichinæ may occasionally be eaten with apparent impunity, we do not conclude that the fatal cases of trichinosis are not invariably due to the ingestion of infected meat.

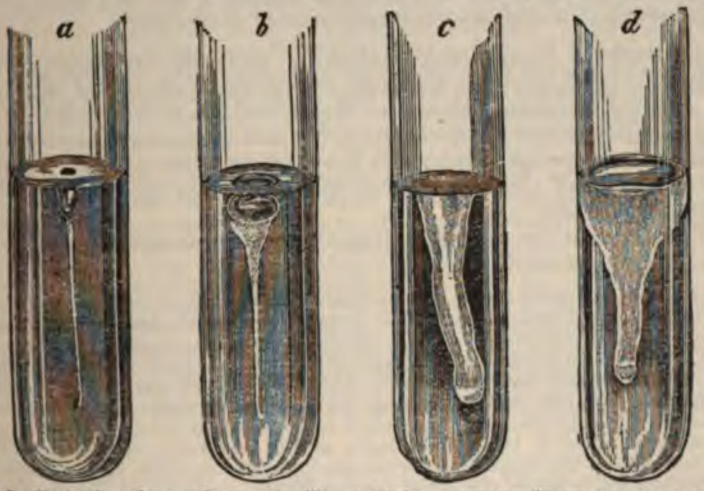

FIG. 8.—Test-tube cultures of curved bacilli. *a*, Koch's comma-bacilli two days old; *b*, the same four days old; *c*, the Finkler-Prior microbe two days old; *d*, the same four days old. (Johne.)

As a further illustration of the kind of criticism that has been bestowed upon Koch and his doctrine, we may also instance the following:

> Dr. George Waters, writing to The Lancet (January 31, 1885) from Bombay, says that he found curved bacilli, identical in shape, size, and appearance with comma-bacilli, in nearly all microscopic examinations of mucus from the small intestines of persons who had died from ordinary affections. He has also found identical organisms in neutral or slightly alkaline urine. In human urine he found curved bacilli within five minutes of its being voided from the bladder.
>
> Nevertheless he regards the comma-bacilli as an indubitable pathological feature of cholera, but more in the shape of a consequence than a cause of the

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[1] Journal de Micographie, quoted in St. Louis Med. and Surg. Journal, January, 1885.

malady. Further on he believes the organism in question should be regarded more as a physiological than a pathogenic entity.

He concludes as follows: "If I say that a superabundance of comma-shaped bacilli is found in the small intestines of cholera victims, because it would appear that whatever gives rise to that ailment brings about exalted fermentation in that part of the alimentary canal, I shall, at least, have as much logic in my assertion as Koch had in declaring that these organisms must bear a causal relation to the disease."

Now it is time that this kind of criticism ceased to receive the dignity of being printed in our leading medical journals. Waters makes no cultures; he merely sees something that looks like a curved bacillus, and immediately proclaims to the world that the results of months of arduous labor and cautious inquiry go for naught in the light of his puerile investigations. As a matter of fact, I have examined urine both in health and disease, both fresh and stale, and can assure you that I have discovered no bacteria in it that a good microscope cannot at once show to differ from Koch's commas. And, moreover, as has been pointed out again and again, even complete identity of size and shape would be far from proving identity in pathological potency or virulence.[1]

But of all the blows struck against the universal acceptance of Koch's bacillary doctrine, perhaps the most severe one is contained in the paper read recently by Klein, before the Royal Society, and entitled "On the Relation of Bacteria to Asiatic Cholera." For this communication embodied the results of a special inquiry into the etiology of the disease, undertaken at the instance of the Government by Dr. Gibbes, Mr. Lingard and the reader of the paper.

The investigations of this English Cholera Commission have led to the following conclusions:[2]

1. Koch's statement as to the constant occurrence of comma-bacilli in the rice-water stools of cholera patients is correct; the comma-bacilli vary greatly in numbers in different stools and in different cases, in some being exceedingly scarce, in others numerous. 2. These comma-bacilli vary greatly in length, some being twice and three times as long as others, some well curved, as much as to form half a circle, others showing only just a slight bend. The name comma-bacillus is inappropriate; the organism is more correctly termed a vibrio. 3. The comma-bacilli occur in the mucus-flakes of the rice-water stools, as well as in those taken from the ileum of a person dead of cholera. The sooner after death the examination is made, the fewer comma-bacilli are found in the mucus-flakes; even in typical rapidly fatal cases, the mucus-flakes taken from the ileum, and examined soon after death (from between fourteen minutes to an hour or an hour and a half) contain the comma-bacilli only very sparingly indeed, and not to the exclusion of other bacteria. Our investigations do not bear out Koch's statement as to the lower part of the ileum being, in acute typical cases of cholera, almost "a pure cultivation of comma-bacilli." In not one of the many post-mortem examinations of typical acute cases have we found such a state. 4. The mucous membrane of the ileum, in typical rapidly fatal cases, if examined soon after death, does not contain in any part any trace of a comma-bacillus or any other bacteria, not even in the superficial loosened epithelium. If the post-mortem examination be sufficiently delayed, comma-bacilli and other bacteria may be found penetrating into the spaces of the mucous membrane. Koch's theory as to the comma-bacilli present in the mucous membrane secreting a chemical poison inducing the disease cannot, therefore, be correct. 5. Neither the blood nor any other tissue contains comma-bacilli or any other micro-organisms of known character. 6. The behavior of the comma-bacilli in artificial media is not such as to justify their being considered as specific. They grow well in alkaline and neutral media, are not killed by acids, and their mode of growth in gelatine mixtures is not more peculiar than that of other putrefactive bacteria; they show marked differences when grown in different media, but not more so than the ordinary putrefactive bacteria when compared in their growth with one another. The

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[1] Quoted from a paper read by the editor before the Medical Society of the County of New York. The Medical Record, February 28, 1885.

[2] British Medical Journal, February 7, 1885.

comma-bacillus of the mouth shows the same peculiar character of growth in gelatine as Koch's comma-bacilli. 7. Koch overlooked the fact that comma-bacilli occur in other intestinal diseases, in the mouths of healthy persons, and, as shown recently, even in some common articles of food. 8. The experiments performed by Koch and others on animals do not in the least prove that the comma-bacilli are capable of producing cholera or any other disease. The results obtained by them are much more easily explained in an opposite manner. 9. There is direct evidence to show that water contaminated with choleraic evacuations, and containing, of course, the comma-bacilli, when used for domestic purposes, including drinking, by a large number of persons, did not, in the case of the tanks near the Jelepara lane, produce cholera. 10. The mucus-flakes taken from the small intestine of a typical rapidly fatal case of cholera, contain numerous mucus-corpuscles filled with peculiar minute straight bacilli; in this state they are found when the examination is made very soon after death; soon, however, the mucus-corpuscles swell up and disintegrate, and then their bacilli become free. The small bacilli are never mixed in the mucus-flakes. They are one-third or one-fourth the length of the comma-bacilli, and about half their thickness. They are non-mobile; they grow well in Agar-Agar jelly, but show in their modes of growth no peculiarity by which they could be considered as specific. When grown on the free surface of the nourishing material they form spores. 11. These small bacilli are not present in the blood, in the mucous membrane of the intestine, or in any other tissue. 12. Experiments made with these small bacilli on animals produced no result. 13. Since my return to London, I have ascertained that the comma-bacilli of cholera show two distinct modes of division, one the known one of transverse division, and a second one of division in length. When growing in Agar-Agar jelly at the ordinary temperature of the room, after some days the bacilli swell up, owing to the appearance in their protoplasm of one or more vacuoles; as these vacuoles increase, so the comma-bacilli become gradually changed, first into plano-convex, then into oblong bi-convex, and ultimately into circular corpuscles. The longer the original comma-bacillus, the larger the final circle. These circular organisms are mobile, just as are the comma-bacilli; and, by disintegration of the protoplasm at two opposite points, two perfect more or less semicircular comma-bacilli are formed. Growing the comma-bacilli in Agar-Agar jelly kept at higher temperatures (86°–132° F.), the comma-bacilli multiply by transverse division only; but, transferring these to Agar-Agar jelly, and keeping this at the ordinary temperature of the room, they again gradually change into circular organisms, which, by division in the diameter of the circle, form two new comma-bacilli.

From an examination of these conclusions, it would appear that the English inquirers boldly take issue with every one of Koch's conclusions. The only item in which they are not in conflict with him consists in their admission of the constant association of comma-bacilli with Asiatic cholera. But even this circumstance is not interpreted by the Englishmen in Koch's sense. Before passing final judgment upon the value of the British Commission's opinions, we will have to receive the full account of their labors. Their work seems to have been merely negative. New light is not shed upon the question by the results of their inquiries.

So, too, the recent discussion on cholera, before the Royal Medical and Chirurgical Society,[1] while in many respects exceedingly interesting, failed to clearly establish any other point than that there still exists an extreme divergence of opinion regarding the etiology of the disease. Those who accepted Klein's statements and those who sided with Koch appeared to be about equally divided, although the strongest arguments were marshaled in support of the German doctrine.

From these mostly adverse criticisms we turn now to certain inquiries the results of which are more or less distinctly confirmatory of Koch's statements. And it may be permissible to remark at the outset that up to the present, the supporting observations more than counterbalance the negative evidence of opposing conclusions.

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[1] The British Medical Journal, March 28, and April 4, 1885.

The Investigations of Babes.—Dr. Victor Babes had an opportunity of studying the comma-bacillus in Professor Cornil's laboratory during the cholera epidemic in Paris, in November, 1884.[1] He first sought to determine whether, as is maintained by Koch, but questioned by several other observers, the comma-bacilli are always present in the intestinal contents of cholera patients. The cases examined by him composed ten in the early stage of the disease and five at a later period. In about one-third of these cases the contents of the intestine contained scarcely any other bacterial forms than the comma-bacilli, but in the remainder the comma-bacilli were only one of several different forms of micro-organisms, and were sometimes present in such small numbers, and were so far from being characteristic in their appearance, that it would have been hardly safe to assert the existence of cholera from this examination alone. In two cases examined at a late stage of the disease absolutely nothing was found that could be called comma-bacillus. The author states, however, that he has never found the comma-bacilli in the intestines of individuals suffering from any other disease than Asiatic cholera. Curved bacilli are found in the buccal secretions, in water, in decomposing albuminous substances and in fecal matters, but they differ decidedly from Koch's bacilli both in form and in their behavior in cultures. The results were very different, however, when cultures were made from portions of feces or from the whitish collections found lying over Peyer's patches. In nine out of ten cases of cholera in the early stages, characteristic cultures were obtained, and in the only negative case it was not improbable that the failure was attributable to an error in the preparation of the specimen. Of the five remaining cases in which the disease had existed from six to ten days, two of the culture experiments were negative in their results. Koch's method of obtaining pure cultures was followed. It was often found preferable not to put the little white flocculus from the intestinal contents directly into the gelatine, but first to mix it with five grammes of distilled water and then to put one drop of this water into ten grammes of gelatine. In many instances these two methods were combined. When the gelatine plates were exposed to a temperature of 62° to 68.5° F., cultures were developed at the end of twenty hours in the form of small opaque points, or as depressions the size of a millet seed, presenting the appearance of little bubbles of air. From the latter, which were often present in very small number, were developed the characteristic cultures differing in appearance according to the degree of concentration of the gelatine. In 6 to 8 per cent. gelatine solutions the little bubble-like forms were scarcely visible, and the culture consisted of a little round, somewhat sunken speck, in the midst of which was a yellowish white point. When the cultures are not too close together—and this can be avoided by employing the above-mentioned method—they are most characteristic at the end of two days. They consist then of a sharply defined, opaque white circle, 2 or 3 mm. (a line to a line and a half) in diameter, within which is a second circle formed of granules, and within this the gelatine is turbid and liquefied. In the middle of the culture, below the surface of the gelatine, lies the yellowish white point which, when magnified, is seen to be of an irregular star shape, crumbling, and somewhat transparent. The thinner the mother fluid is, the more rapidly is the culture developed and the flatter it is; and the harder the mother substance is the more sharply defined is the depression corresponding to the culture. Although many other bacteria may form similar cultures, yet that of the comma-bacillus in a 10 per cent gelatine solution is perfectly characteristic. In this at a temperature of 64° F. after two days there is seen an oblong bubble-like depression, scarcely five millimetres in diameter, beginning at the surface, and from this follows a white, twisted or pulpy looking thread, almost one millimetre in thickness, which often ends in a hook-shaped or spherical enlargement. In agar-agar the bacillus grows almost entirely on the surface; it spreads along in a thin, rather moist and pulpy, yellowish white, semi-transparent layer which, at a temperature of 96° F. covers the entire surface within fourteen hours. The film of fluid which ordinarily lies over the firm agar-agar becomes cloudy and deposits a white sediment. In blood serum at the temperature of the body there is developed within twelve hours, starting from the point of insertion, a globular, bladder-like, turbid sack, taking in half of the mass of the serum. Later the upper portion of the serum becomes liquefied, and at the bottom of the fluid layer so formed is a light yellowish sediment.

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[1] Progrès Médicale, December 6, 1884, and Virchow's Archiv., vol. 99, part 1, January 2, 1885.

The comma-bacilli were successfully cultivated at a temperature of 96° F. in milk, fresh meat, boiled eggs, bouillon, boiled potatoes, carrots, cabbage, and very sparingly in moistened bread and beans. The bacilli retained their life for forty-eight hours, but formed no visible cultures, in fecal matter, cheese, fresh vegetables, potatoes, fruit-juice, sugar-water, water from the Seine, chocolate and coffee. The bacilli died in distilled water inside of twelve hours. A culture was gradually heated during four hours up to 185° F. and then attempts made to transplant it in gelatine. Up to 113° F. cultures were readily developed, but after a temperature of 114° to 118° no new culture was formed. At 122° F. transplanted cultures were developed as bubble-forms, an appearance which undoubtedly indicates a dying condition of almost all bacilli with very few exceptions. When rapidly heated, cultures were sterilized only at a temperature of 166° to 175° F. Pure cultures, either in gelatine or agar-agar, were not dead at the expiration of nearly two months, but a culture which was mixed for the same length of time with filth-bacilli contained no more viable comma-bacilli. When sublimate was added to the gelatine in the proportion of 1 to 30,000, traces of growth of the comma-bacilli were evident after several days, but the gelatine was not liquefied until the proportion was reduced to 1 to 100,000 or 1 to 150,000. *A solution of the strength of* 1 *to* 15,000 *was necessary to arrest the development with certainty.*

The following disinfectants were tested as regards their action on the comma-bacilli, the gelatine or broth being prepared with a definite percentage of the disinfectant, and then sown with pure cultures: In 1 pint of carbolic acid to 1,000 parts of gelatine, the comma-bacilli were developed, but the culture perished within a few days. The same thing occurred in a mixture of sulphate of copper of 1:3,000–5,000; salicylic acid, 1:800–900; thymol, 1:9,000–10,000; iodine, 1:600–800; bromine, 1:600; alcohol, 1:15; acetic acid, 1:2,000; sulphate pf quinine, 1:800 (?).

When a larger percentage of the disinfectants than that given in the foregoing was used, the cultures were not developed at all, as a rule. In weaker solutions they were developed better, but still rather sluggishly. Permanganate of potassium threw down a brown sediment in the gelatine, but did not interfere with the bacterial growth.

Dr. Babes made a few experiments upon animals with apparent success. Two white mice were inoculated at the root of the tail with a pure culture in gelatine, and both died after a few hours. Pure cultures of the cholera bacillus were obtained from the blood and the spleen, and in one of the animals that died twelve hours after inoculation large numbers of comma-bacilli were found in the whitish fluid contents of the intestinal canal. Another mouse was inoculated by means of a needle at the root of the tail, and was in a sort of stupor for several days after. The abdominal cavity of a rabbit was opened and three minims of a pure culture were injected into the duodenum, but the animal quickly recovered and remained well. Two guinea-pigs were treated in the same way. One died at the end of three days with diarrhœa, and the intestine presented the appearance of cholera with rice-water contents and injection of Peyer's patches. The intestinal matters contained large quantities of comma-bacilli. The other guinea-pig recovered completely after three days. This experiment was repeated without, however, giving any positive results. This writer describes the comma-bacillus as follows: When fully developed in the intestine or in a culture of some days' growth, it is seen in the form of a segment of a circle and is of a pretty constant thickness of 0.4 to 0.5 mmm., and of a length of 1 or 2 mmm. Under a moderate magnifying power it seems to be homogeneous and of equal thickness throughout its entire length. But when living stained bacilli are examined under a high power ($\frac{1}{12}$ Verick or $\frac{1}{24}$ Hartnack and 4 eye-piece with elongated tube), three parts are seen: a stained integument, colorless contents, and a strongly stained substance which is usually collected at the ends of the roots in rounded, more or less sharply defined masses, between which one or two pale spaces are seen, giving the appearance of spores. Sometimes bacilli with sharpened extremities, having a crescentic appearance, are seen; in other cases the ends, either one or both, are thickened. Often two rods are united in the form of an S, or several are joined as spirilla. The spirilla are thicker, more homogeneous, and receive a deeper stain than the single rods. A ten-hour culture in agar-agar often contains very short bacteria about 0.7 mmm. in length, but they are nevertheless characteristic, one side being always concave so that they resemble a millet seed or a bean.

In their further development the rods increase in length, while the chromatic substance contained within them is movable, being observed now at one end, now at the other, and again in the middle. When the rods have attained a certain length this substance collects in the middle portion, forming sometimes a thickening of the rod in this part, and then through its center appears a light disk at the point where the division is to occur. Before the rod is ready for division it is usually S-shaped or rather spiral. When division takes place there is noticed first an S with an attenuated middle part, and then later the two distinct rods are seen joined together by a fine unstained line with double contour, which is long and flexible, allowing free motion to the separated rods, but which often remains unbroken for a considerable length of time. This persists sometimes for so long a time that the primarily separated rods become each again divided while still connected by this intervening substance, so that chains of single rods are formed. The bacilli often become elongated without any fission taking place. In such cases the threads thus formed may either show dark points at the places where the fission should occur or else may seem to be homogeneous throughout. These spirilla possess a rapid energetic movement at first, but later become more sluggish, thicker, glistening, and receive a more intense stain than do the rods. The short and separate rods are formed when the process of development of the micro-organisms is more rapid, and the slower is the growth and the more unfavorable for it is the mother-substance, the more often are the longer shapes—chains of bacilli and threads—met with.

About a year previous to the above investigations, which were made in Paris, the author had examined a preserved specimen of intestine taken from a patient dead ten years before of cholera, and had been enabled to demonstrate the presence of comma-bacilli. The specimen was stained in an alcoholic solution of fuchsin, then washed in alcohol, and the excess of staining removed by a weak sublimate solution. After this the sections were placed in alcohol, then in oil of cloves, and finally in Canada balsam. The comma-bacilli receive a less clear staining in sections than other bacteria, and in old preparations especially they can be seen only when the sections are very thin. In the specimen examined at that time the bacilli were seen located in the most superficial layers of the mucous membrane of the ileum. A peculiar pallor of the superficial layers of the mucosa, a hyaline degeneration of the intestinal glandular epithelium, and a great increase of granular matters about the vessels and at the borders of the changed tissues, were seen. The same changes were seen in the recent investigations. The bacilli, usually mixed with fecal bacilli, lay for the most part superficially or else beneath the swollen hyaline epithelium of the glands. In the mucosa the bacilli were seen lying irregularly in no definite order. Later, when the dysenteric-like processes are added to the above-mentioned changes, bacilli penetrate into the deeper tissues where they may be massed together in considerable numbers. These are ordinarily somewhat larger than the cholera-bacilli, and resemble the bacilli of typhoid fever. In a few instances micrococci colonies may be observed in the necrosed mucous membrane. Despite careful examination of the internal organs, in which—in the kidneys especially—marked parenchymatous changes had occurred, no bacteria of any kind were found. In order to determine whether there really are no comma-bacilli in the blood and internal organs in cholera, Dr. Babes made a number of culture experiments. In one instance, in which a piece taken with every precaution from the kidney was used, a liquefaction of the gelatine occurred, and from this pure cultures of comma-bacilli were obtained. In no other case, however, was this result obtained, and the writer is inclined to attribute his success in this instance to a possible error in the process employed.

In conclusion, the author states that his investigations, as far as they go, corroborate Koch's description of the comma-bacillus, and are in accord with those of Van Ermengem, Rietsch and Nicati as to the causal relation between this bacillus and Asiatic cholera. They showed also that the comma-bacillus, while most characteristic when cultivated in gelatine of a certain strength and under certain conditions, nevertheless has peculiarities of its own which render it distinguishable from other forms of bacteria when cultivated in other media. By means of cultures in different media, also, the author was enabled to throw some light on the causes for the slight modifications of form that have been described. It also seemed desirable to observe the action of bacilli in the various articles of ordinary diet, and especially in water. It was found that while the bacillus remained viable in distilled water for a very short time only, in the ordinary water supply of cities and in river water it lived for seven days and even longer. It was also shown that the bacilli bore high temperatures very ill, and were killed at 175° F. or, when the heating process was more gradual, at 157.5°. The action of the comma-bacillus in the presence of disinfectants was also interesting, as it was shown that much stronger solutions were necessary to destroy them than are needed to cause the death of other bacterial form. In general the volatile disinfectants were found to be practically more valuable than those which required to be brought into immediate contact with the bacteria.

Doyen's Researches.—Dr. M. E. Doyen, in the Gazette des Hôpitaux December 18, 1884, reports the results of his investigations concerning cholera during the recent Parisian outbreak. The work was done in Prof. Cornil's laboratory. The intestinal contents and viscera of choleraics were examined shortly after death. In every instance comma-bacilli were found, both in the fluid contained in the bowels and in the coats of the intestine. In "foudroyant" cases, these bacilli were found as pure cultures inhabiting the duodenum and upper portion of the jejunum. In cases of slow development the commas occurred only in the ileum, and were found there together with a variety of other bacteria. Doyen infers from this peculiarity a migration from above downward of the comma-bacilli.

In the liver, kidneys and spleen, especially in the two first-named organs, various bacteria were found, and raised in cultures. They included comma-bacilli, diplo-cocci, micrococci in chains, and large rods. Straight bacilli, or more frequently curved ones, C and S shaped, and corkscrew-like organisms were always encountered in those viscera.

He attaches great importance to the fact that their presence in the interior of blood-vessels was likewise ascertained. The short interval occurring between death and the time of the examination excludes, according to Doyen, the possibility of the cadaveric origin of his bacteria. He concludes, therefore, that in cholera a "complex septicæmia" occurs. It is of intestinal origin, and easily explained by the epithelial desquamation. The intestinal bacteria are allowed to penetrate into the walls of the bowel, and may thus enter the circulation. Like Koch and Nicati, he was able to induce cholera in dogs and guinea-pigs.

When Doyen communicated his observations to the Paris Biological Society (meeting of December 13th, 1884), M. Malassez very properly questioned whether the discovery of cholera bacteria in the blood could be claimed by the reader, for he had admitted that the blood was examined after death in all his cases.

M. Straus also remarked that in innumerable specimens of choleraic livers he had never been able to discover microbes.

The Investigations of Van Ermengem.—Dr. Van Ermengem having made a series of investigations touching cholera, communicated to the Microscopical Society of Belgium, on October 26th, 1884, the following conclusions:

1. In the intestinal fluids of patients attacked with cholera (eight autopsies and thirty-four examinations of stools) there exists an organism identical with the comma-bacillus discovered by Koch.

2. Its curved shaped, its S-shaped and chain-like groups due to juxtaposition, and its occasional formation of slightly wavy filaments, give an assemblage of microscopical characters which render it easily distinguishable from pathogenic micro-organisms hitherto known.

3. It is more or less abundant in the choleraic products according to the period of the disease and the time of examination. In two rapidly fatal (*foudroyants*) cases it occurred in the intestinal contents almost in a pure culture. In one case of short duration, where the patient had succumbed with very marked algid

phenomena, there were very few comma-bacilli to be found in the intestinal fluid. They disappear from the darker stools of the reaction stage.

4. It would have been very important to find them in the dejecta of patients attacked with so-called premonitory diarrhœa, but our investigations could not be brought to bear on this point.

5. In the single case of algid cholera, where microscopic examination failed to detect numerous comma-bacilli, a culture of a small quantity of the intestinal contents on soiled linen in a damp chamber yielded an incalculable number of characteristic comma-bacilli in twenty-four hours.

6. Microscopical examination of dejecta can suffice to establish the diagnosis of Asiatic cholera, when preparations containing the different forms of comma-bacilli in excess are obtained.

7. Bacterioscopic research supplies the deficiencies of microscopical examination in cases where the comma-bacilli are scanty, and are even not found with certainty in the preparations. The characteristic aspect of their colonies, studied under a low power (150 diam.), renders them easy of recognition. The practical value of these culture processes on the glass slide in nutrient gelatine (10 per cent.) is well shown by our experiments. Mixtures of a very small quantity of the cultivation product with a considerable amount of putrefied blood, stagnant urine, fecal matter, hay infusion, etc., yield preparations where the typical colonies of comma-bacilli have been detected with readiness in the midst of most varied vegetation.

8. The study of the morphological characters of the comma-bacilli at different stages of development, cultivated in various media, chiefly in chicken broth and fluid serum, shows that they are nearly related to true spirilla.

9. The most varying conditions of temperature and medium have not resulted in the discovery of a stage of spore formation; and their want of resistance to drying proves that they do not produce permanent germs.

10. Gelatine cultures cease to be inoculable six or seven weeks after having been sown. Agar-agar cultures still contain living organisms after eight to nine weeks.

11. The temperature most favorable to their development seems to be that of from 75° to 98.5.° F. Below 61° (between 46.5° and 59°) they are still developed, but with difficulty.

12. Their phenomena of growth and multiplication are extremely active. In from two to three days they completely liquefy many cubic centimetres of coagulated serum.

13. The curved bacilli of the saliva, discovered by Miller, and believed by Dr. Lewis to be identical with the choleraic comma-bacilli, do not develop in gelatine of 10 per cent.

14. The cultures of the organisms, to which MM. Finkler and Prior attribute the production of cholera nostras, are impure. That which I examined contains two kinds of bacilli. Their mode of vegetation and the appearance of their colonies in gelatine differ from those of the comma-bacilli of Asiatic cholera. One of them gives to the cultivating medium a very characteristic greenish-blue fluorescence, which is wanting in the pure cultures of the comma-bacilli.

15. Attempts at inoculation of the cultivation products have so far yielded very encouraging results in some species of animals, such as dogs, rabits and guinea-pigs. Three out of four guinea-pigs died in two or three days after the injection into the duodenum of one drop of a culture (fourth day) of the comma-bacilli in liquid serum, after the method pursued by MM. Nicati and Rietsch, of Marseilles. The cadaveric appearances were those of cholera, and the intestinal fluids contained large numbers of comma-bacilli.

16. The pathogenic action of these culture products is probably a zymotic one. The ferment appears to be a readily decomposed compound albuminoid. Fresh red blood-corpuscles placed on Ranvier's heated platina stage show characteristic changes when brought in contact with a drop of culture serum. These changes correspond to those described by Nicati and Rietsch as occurring in the blood of cholera patients.

17. The discovery of the cholera-bacillus is of utmost importance in the diagnosis of doubtful choleraic diseases occurring at the commencement of an epidemic, and also for the establishment of prophylaxis; for an early diagnosis will enable us to institute timely measures for prevention.

18. The employment of bacterioscopic methods does not present great practical difficulties. In view of the threatened invasion of Belgium, it would appear

advisable that a sufficient number of physicians proceed to Berlin to acquire the necessary proficiency in carrying out such examinations.

Still more recently Van Ermengem presented an important communication to the Belgian Academy of Medicine (Bulletin de l'Acad. Royale de Méd. de Belgique, Vol. XVIII., No. 12., 1884), on the inoculation of guinea-pigs with the products of comma-bacilli cultures.[1]

The author begins by pointing out that the transmissibility of cholera from man to the lower animals has been in turn affirmed and denied by many observers. In all epidemics facts have been observed which were thought to point conclusively to cholera infection in dogs, cats, birds, etc.

Reputable authorities, such as Magendie, Meyer, Thiersch, Charcelay, Crocq, Legros and Goujon, Leyden, Burdon-Sanderson, Popoff and others have conducted experiments the results of which seemed to them to be conclusive. But on the other hand the force of these positive results has been weakened by the negative conclusions of other experimenters, chief among whom are Schmidt, Guttmann and Baginski, Stokvis, Snellen, Högyes, Wolffhügel, and especially the commissioners of the English Sanitary Council in India. The unfailing want of success in the experiments recently undertaken for the same end by the members of the French and German missions in Egypt and Calcutta respectively has tended still further to establish the opinion that most of the lower animals are not susceptible to the action of the cholera poison.

In the face of these contradictory facts, it might be asked whether the choleraic symptoms sometimes observed were actually those of cholera. And this doubt is increased when the conditions of most of the experiments are more closely examined. Not only were the symptoms far from being always characteristic, but the lesions discovered post-mortem were very diverse in character, and in many cases no autopsy was made at all. And besides, many sources of error, which have since been found to exist, were often not guarded against. Poisoning by ptomaines might explain many of the phenomena observed; and the experiments made some time ago by Stich have shown that the introduction into the circulation of excrementitious products contained in the urine or feces may give rise to symptoms resembling greatly those of the algid stage of cholera. Then again, it required massive doses of the virulent material to produce tangible results, small doses, except possibly in the case of mice having failed to excite alarming or fatal symptoms. Finally, facts were wanting to establish the poisonous nature of the dejections of the animals which were the subjects of experiment.

Thus it may be said that the experimental study of cholera, until very recently was just where that of tuberculosis was prior to the memorable investigations of Villemin, Martin and Koch. Pseudo-cholera has been produced by matters of the most varied kinds, but proof is still wanting that the disease thus caused is specific in its nature and re-inoculable.

Van Ermengem had made a few attempts at inoculation in dogs without very definite results, when he learned of the experiments upon guinea-pigs conducted by Nicati and Rietsch. They seemed to him important as indicating that these rodents were, in a special manner, susceptible to the action of the cholera poison, and he therefore turned his attention to them, using them in a series of searching and varied experiments.

The first experiments were made by injecting eight to fifteen drops (0.5 to 1.0 grm.) of a pure culture of comma-bacilli into the duodenum. Every one of the animals died presenting typical symptoms of malignant cholera, and the autopsy revealed lesions which completed the picture of the disease. Microscopical examination showed the presence of comma-bacilli in the contents of the intestine.

Several guinea-pigs were then submitted to an injection, in a similar manner, of a fraction of a drop of the culture fluid, the dose varying from 1-5 to 1-80 of a drop. Only one of the animals survived, and he presented some passing algid symptoms and had a diarrhœa for several days. His stools contained comma-bacilli nine days after the inoculation, which had been of about 1-50 of a drop only of the culture fluid. All of the other animals died with choleraic symptoms, differing but little in intensity from those excited by the large doses. The lesions found post-mortem were those of cholera, and numbers of comma-bacilli were discovered in the intestinal contents.

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[1] From an article by the editor on "Recent Researches in Cholera," published in the Medical Record, February 28, 1885.

Another series of experiments was made to determine the virulence of intestinal matters taken from the animals subjected to the former inoculations. The subjects of these experiments died with choleraic symptoms, as did also other animals inoculated with their morbid products, the latter being, therefore, the third in the series.

Injections were now made with the products of cultures from which the bacilli had been removed by filtration, or had been killed by heating the culture to 140° F., or over, for half an hour. In these experiments, when large doses were injected, the animals speedily succumbed with algid symptoms, but when small quantities were used no effects were produced.

To assure himself against error the author also examined microscopically the stools and the intestinal contents of healthy guinea-pigs. He sometimes found bacteria of a curved form and well-developed spirilla, but it was always easy to distinguish these from Koch's bacilli, for they were from two to four times larger than the latter, and differed from them also in their action in culture media. Similar forms were also found in the excrement of other animals and in impure water.

That the abdominal section required in order to make the duodenal injections was not the cause of the death of the animals, was shown by the recovery of several guinea-pigs subjected to the various experiments, for in them the wound healed readily without exciting any untoward complications. Several of those animals that recovered from the first operation were used a second time, and died with the usual choleraic symptoms. This would seem to show that one inoculation with the comma-bacilli does not confer immunity.

Duodenal injections were also made of septic materials other than those containing comma-bacilli, and in most cases were barren of result. In some few instances the animals died with symptoms of septicæmia, but never with those of cholera.

In reviewing the results of his various experiments the author maintained that they were sufficient to prove that cultures of the comma-bacilli contain a very active toxic principle, which can only be the product of the vital activity of this microbe. This poison causes morbid phenomena and cadaveric lesions, differing but little from those of Asiatic cholera. He hoped to be able, with the assistance of a skilled chemist, to isolate this principle, and to compare it with that which Dr. Pouchet had recently succeeded in separating from the rice-water stools.[1] If these attempts were successful they might suffice to establish a very important similarity between the phenomena observed in experimental cholera and those which characterize the disease in man. In two autopsies of malignant cholera made by the author, there was such an absence of grave lesions that it was difficult to explain the fatal result by any changes in the intestines or other organs; the blood alone was profoundly altered. Similar discoveries have recently led Koch,[2] Straus and Roux,[3] and Klebs,[4] to admit that, in these cases, a powerful poison is produced in the intestine, to the absorption which these grave constitutional symptoms and speedy deaths are to be attributed. The injection of filtered cultures, Van Ermengem stated, has caused in guinea-pigs a condition presenting the strongest resemblance to an attack of hyper-acute dry cholera.

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[1] Comptes rendus de l'Acad. des Sciences de Paris, No. 20, 1884.

[2] Conferenz z. Erörterung der Cholerafrage; Deutsche Med. Wochenschrift, No. 32, 1884.

[3] Bulletin de l'Académie de Médecine de Paris, August 6, 1884.

[4] De l'Étiologie du Choléra. In Ann. de la Soc. Médico-chir. de Liège, No. 11, 1884.

CHAPTER XXIV.

THE CHOLERA MICROBE OF EMMERICH; WITH OTHER OBSERVATIONS FOR AND AGAINST KOCH.

The Microbe of Emmerich.—Dr. Rudolph Emmerich was sent by the Bavarian Government to Naples for the purpose of studing Koch's comma-bacillus in its relations to Asiatic cholera. An account of his observations was read at a recent meeting of the Medical Society of Munich (December 3, 1884). His material consisted of ten cases. In eight of these there was no difficulty in finding Koch's commas. In the remaining two they were missed.

But in addition to the comma-bacilli, his glass-plate cultures showed colonies of another variety of microbe. Indeed, the latter sometimes preponderated over the comma colonies. Believing, however, that the mere discovery of a peculiar organism in the intestinal contents, and apparently nowhere else, could not sufficiently account for the disease, he decided to search elsewhere for their presence. He thought that the visceral lesions of cholera might, perhaps (reasoning from analogy with other infectious diseases), receive their explanation from the presence of cholera microbes within their substance.

Emmerich examined the blood and various organs of choleraic bodies by inoculating tubes containing sterilized solid culture media of various kinds. These tubes were then taken to Munich and their microbes studied by means of glass-plate cultures. In this way he discovered a new organism, held by him to be the true cholera microbe.

The same pathogenic organism he succeeded in cultivating from the blood of a young woman who was in the collapse stage of the disease and died six hours after the blood was withdrawn from the median vein. He describes his method of procedure in the following manner:

The surface having been carefully washed with water, alcohol, and a one per cent. solution of corrosive sublimate, the vein was punctured, and the blood, which was observed to be thick, trickled slowly out. The first drops, having been carefully got rid of, a previously heated platinum wire was passed into the vein, and on being withdrawn was then introduced into a test-tube containing solidified nutrient gelatine, and the latter was pricked in three places. Ten such tubes were inoculated in this manner, and it was afterward found that organisms developed in three of them. The remaining seven tubes continued to be sterile.

The organisms thus cultivated were always of one kind. They have a cylindrical form with rounded ends, and are found, either singly or in pairs, rarely with more than two segments. The length of each microbe is about one and a half times that of its width. According to Cohn's classification, therefore, they are bacteria, or better, short bacilli. As regards shape and size they resemble those found in diphtheria, but are to be distinguished from the latter by the form of their colonies, when grown in gelatine and examined under a low power, and also by their action upon animals. They grow at ordinary temperatures in slightly alkaline gelatine as solid milk-glass-like patches. They do not liquefy the gelatine. Under a power of one hundred diameters such of the colonies as develop in the deeper portions of the nutrient gelatine on the glass plate present the form of a millstone, and those on the surface simulate flat, circular mussel-shells. The deeper colonies look yellowish-brown by transmitted light, white by reflected light, and have a finely granular appearance. The more superficial colonies are pale yellow toward the middle, and whitish at the margin. They manifest a tendency to spread over the surface as a thin transparent coating.

In cultures from the viscera they were found to be most numerous in the kidneys and liver, then in the lungs, and least numerous in the spleen. Emmerich ascertained that the greater number of the gelatine plates which were inoculated with the blood and with the juices of the several organs in cholera yielded, even in the first generation, a pure culture of this bacterium. The microbe has also been detected without resorting to cultivation in sections of the intestine and of the kidney. Other organs have not as yet been examined. Great numbers may be detected in the dejections and in the intestinal contents after death. They were found to grow in every gelatine-plate cultivation of choleraic alvine material, and in some cases occupied almost the entire surface of the plate; whereas in other cases, though more seldom, comma-shaped bacilli prevailed, but never to the exclusion of the particular organisms in question.

The results of some inoculation experiments made at the Hygienic Institute of Munich, in conjunction with Dr. Sehlen, were also described. The animals experimented upon were for the most part guinea-pigs, and he believed that lesions had been induced in them by inoculation with this bacterium, which closely resembled those observed in persons who had died of cholera, and especially as regarded the small intestine. The changes had been noticed to vary from a simple desquamative catarrh, with rice-water-like intestinal contents, to hemorrhagic exudation and ulcerative destruction of the mucous coat. A few drops of a solution prepared by the addition of a fragment of this bacterial cultivation to two or three drachms of distilled water, injected subcutaneously or into the lungs, gave rise to a protracted illness of from five to six days, accompanied with deep-seated changes in the intestinal mucous membrane. The injection of a larger fragment of the cultivation, covering an area of about a quarter of an inch, suspended in water, was followed by death in from sixteen to thirty hours, but with less marked pathological lesions in the intestine. The severity of the intestinal lesions were thus the more marked the more protracted the course of the disease; and the larger the dose the earlier did the fatal termination occur.

The contents of the colon varied with the degree of the affection. It was either a flocculent whitish fluid, resembling rice-water, or more pappy, and in advanced cases mixed with blood. The mesenteric glands were found enlarged, the peritoneum congested, the cœcum and large intestine sometimes showed extensive ecchymoses. The spleen always looked normal.

These assertions of Emmerich were so direct and unequivocal that they created considerable stir in the medical world, especially in Germany.

His methods and results were soon challenged. On the other hand he has himself quite recently attempted to substantiate more fully his claim to the discovery of a new specific cholera microbe. (See below.)

Among others, Professor Flügge, of Göttingen, the well-known author of a treatise on the methods of hygienic investigation,[1] and similar standard works, has published a refutation of Emmerich's positive claims. Flügge,[2] states that Emmerich failed to obtain pure cultures. His alleged new cholera bacillus is merely a septic organism. The results obtained by inoculating animals he could have induced equally well by using cadaveric products from any body not too long dead.

Emmerich's method of obtaining cultures could not stand the rigid test of scientific accuracy, which to-day is essential for experiments of this kind. Apart from all this, it was an error to assume that the cholera microbes must necessarily be present in the blood and viscera in order to afford an adequate explanation of the symptoms of the disease.

The profound visceral changes observed in the bodies of choleraics belonged to protracted cases.

In typical acute cases rapidly terminating in death, marked histological lesions were found only in the intestines. Moreover, the number of cases examined by Emmerich was so small as to make any attempt at generalization seem *a priori* futile. This is the substance of Flügge's criticism, which in turn provoked a rejoinder from another source, namely, from a German observer, a pupil of Nägeli, who, while claiming familiarity with Koch's methods, disclaims all partiality. This writer, Dr. Buchner,[3] of Munich, is inclined to doubt the etiological importance attributed by Koch and others to the comma-bacillus. He questions whether the microbes fulfill the conditions regarded by Koch himself as essential, before we can accept them as the true cause of a given disease. These conditions are "that the bacteria can be invariably detected in such numerical and local distribution as to fully explain the symptoms of the disease in question."

Buchner then attempts to show that the comma-bacillus falls short of this desideratum. Among other things he says:[4]

> It is a mistake to suppose that in cholera it is only the intestine that is affected, and that all the morbid phenomena may be accounted for simply by the transudation of fluid into the intestinal canal. The cases known as "cholera sicca" very decisively show that such is not the case, as, indeed, is acknowledged by Koch, who assumes that a poisoning of the entire system takes place. This assumption, Buchner states, appears to be supported by the observations of histologists, which go to show that, even in the early stages of the disease, a finely granular infiltration of the cells of most tissues takes place; consequently, Dr. Buchner maintains the organisms themselves should be distributed in the tissues generally, whereas comma-bacilli are but seldom to be detected in the intestinal walls even, and not at all in any of the internal organs. To meet the opposition which such a condition invites, Koch assumes that the bacilli generate a poison in the intestinal canal, which passes into the circulation, but it so happens that the intestinal mucous membrane is quite incapable of absorption during a choleraic attack, even allowing that these organisms are capable of evolving a virulent poison, which, however, is wholly undemonstrated.
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> It is further maintained that no corresponding relation exists between the

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[1] Lehrbuch der hygienischen Untersuchungsmethoden. Von Dr. Med. C. Flügge. Leipzig, 1881.

[2] Deutsche medicinische Wochenschrift, January 8, 1885.

[3] Berliner Klinische Wochenschrift, February 2 and 9, 1885.

[4] The language of the paragraph quoted is borrowed from an editorial in the London Lancet of March 14, 1885.

numbers of the bacilli and the severity of the attack, seeing that it is often found that very severe cases of cholera have been observed in which but few could be detected, and, indeed, in which they seemed to be absent altogether. Equally inexplicable on this theory of a poison being generated in the intestinal canal is the extremely rapid reaction which is so frequently observed in the disease; it would be impossible for the bacilli to disappear so instantaneously from the intestinal canal as to account for this, whereas were the organisms distributed generally throughout the tissues of the body, it might reasonably be assumed that they could be rapidly destroyed by the reaction which takes place in the tissue cells. Again, the result of experiments on animals, hitherto so strongly insisted upon as a necessary test of the virulence of any microbe, has, so Buchner claims, in the case of the comma-bacillus, been thus far of a wholly negative character.[1] Taking all these facts into consideration, Buchner maintains that further observations *are* necessary, and that such researches as Emmerich's are not, as asserted by Flügge, superfluous, and even injurious, to the progress of medical science. It is advanced that Flügge was wrong in asserting that Emmerich had found his bacteria in only a certain proportion of the choleraic organs examined; he had, on the contrary, succeeded in cultivating the same species of bacterium from all the tissues investigated, and, as there were some hundreds of gelatine tubes experimented with, any mere accidental development of this organism is out of the question. Professor Flügge further maintained that the mortality which followed the inoculation of guinea-pigs by Emmerich was due to septicæmia, and not to cholera—a suggestion which Buchner meets by saying that whereas in death as a result of sepsis the spleen is invariably enlarged, this organ was found to be small in all Emmerich's cases. It is therefore concluded that the latter has succeeded in isolating an organism in choleraic tissues which is capable of giving rise to a hitherto unobserved malady in animals, and one which corresponds in a marked manner with cholera as observed in man.

The Lancet makes the following significant comment concerning the above:

> Without attempting ourselves to offer any opinion as to the places which these two microbes will occupy in the future as regards their relation to the cholera process, we think that sufficient has been adduced to show that when their respective claims as cholera-causing agents are examined, those of Emmerich's bacterium cannot, as the matter at present stands, be set aside, or simply ignored, in favor of the comma-shaped organism.

On the other hand, as regards the diagnostic significance of the comma-bacillus, Buchner asserts that there can no longer be any doubt.[2] He alludes to the fact that all competent observers have found it. Koch saw it in Egypt, India and France. Klebs and Ceci found it in Genoa; Van Ermengem saw it; Pfeiffer, Babes and Emmerich observed it, and even Klein and Gibbes admit that they always found it. Every one of these investigators recognized it, according to Koch's description, not alone with the microscope, but by the various biological attributes shown in artificial cultures. The author thinks that indisputable credit is due Koch for having discovered by the aid of his excellent methods a parasite peculiar to Asiatic cholera that must necessarily have some importance in connection with the pathology of the disease.

It is significant of the obstinacy with which the cholera-bacillus controversy is being carried on that, as intimated above, Emmerich is by no means disposed to abandon his claim to the discovery of the veritable cholera-microbe.

For at a recent meeting of the Munich Medical Society, he once more gave a full account of experiments, which, since his previous publications, had been supplemented by a series of new observations.[1] He introduced pure cultures of his bacillus into the subcutaneous tissue of many animals, and asserts that almost invariably death occurred, with symptoms closely resembling those of human cholera.

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[1] This statement by Buchner is fatally inexact, as appears from the observations of Nicati and Rietsch, Koch, and especially those of Van Ermengem.

[2] It is somewhat singular that this point is not alluded to by the editorial writer of the Lancet referred to above.

Emmerich particularly emphasizes the fact that the post-mortem lesions were those of cholera. Moreover he states that his so-called "Naples cholera-bacterium" was discovered in the intestinal contents of the animals experimented upon by subcutaneous injection. That it has for the first time been conclusively shown that micro-organisms introduced into the blood may be carried by that fluid to the intestines, and escape into the lumen of the alimentary canal.

Emmerich finally claims that his investigations show that the Naples bacterium is the responsible agent which produces the lesions of Asiatic cholera, and he is convinced that Koch's doctrine is a theory resting on assumptions rather than scientific facts.

As the matter of the rival claims of these organisms at present stands, it is evident that Koch's doctrine has the advantage of many corroborative observations. Nevertheless Emmerich's labors will doubtless still further stimulate scientific inquiry into the precise nature of cholera. And it would be a hasty assumption to suppose that in the face of Koch's plausible doctrine, future research could teach us nothing new with regard to the disease.

Other Views and Observations regarding Koch's Doctrine.—Dr. A. Johne,[2] in a small volume recently issued, and again in an article just published in this country,[3] asserts that the comma-bacillus is the specific microbe of Asiatic cholera. Its discovery in the dejections of suspected cases renders diagnosis certain. He is also convinced that the culture-method of Koch can readily be carried out by the practicing physician. In this way he claims doubtful cases can be made certain in from twenty-four to forty-eight hours.

Dr. A. Pfeiffer,[4] during the recent outbreak of cholera in Paris, had occasion to observe twelve well-marked cases of the disease. The patients represented different ages, from two to sixty-two years, and both sexes. In two cases the attack terminated fatally within a few hours. One case of "foudroyant" cholera sicca was also observed. In six cases autopsies were performed.

In every one of these cases the comma-bacilli were found either intra-vitam or post-mortem in the intestines. They invariably showed a decided preponderance over all other varieties of bacteria. In the three rapidly fatal cases the intestinal contents showed almost nothing beside the commas. In the intestinal glands of hardened specimens the bacilli were also seen by Pfeiffer. Dejections of patients afflicted with other diseases (pneumonia, measles, typhoid fever, phthisis,), were examined, but no commas could be discovered.

Pfeiffer says that he also examined some swelled mesenteric glands of choleraics, but he found no commas in any of them. He says, with reference to Emmerich's claims, that he did not deem it necessary to search for comma-bacilli in the viscera, because he thinks it incredible that in the large number of examinations made by Koch that careful inquirer should have missed them. The Finkler bacillus is, he holds, easily distinguishable from Koch's comma-bacillus. Finally, he is convinced that the latter organism is the cause of cholera, and not a merely accidental occurrence. His reasons for this conviction do not differ from those of Koch for holding a similar belief.

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[1] Berliner Klinische Wochenschrift, April 13, 1885.

[2] Ueber die Koch'schen Reinculturen und die Cholera-bacillen. Leipzig, 1885.

[3] Robert Koch, the conductor of the German Cholera Commission: His Method of Bacteria Cultivation. By Professor A. Johne, in the Journal of Comparative Medicine and Surgery, April, 1885.

[4] Ueber die Cholera in Paris. Deutsche Medicinische Wochenschrift, January 8, 1885.

In the Deutsche Medicinische Wochenschrift, January 15, 1885, Dr. R. Deneke, of the Göttingen Institute of Hygiene, reports the discovery in stale cheese of a species of curved bacilli. Subsequent careful investigations by approved methods brought out the interesting point that, morphologically as well as biologically, they resembled more closely the cholera-bacilli of Koch than did the Finkler bacillus. It is not necessary here to give a detailed account of the points of resemblance and difference. The crucial test was made by inoculating guinea-pigs with pure cultures. In every instance the fluid to be tested was introduced into the duodenum of healthy guinea-pigs by means of a hypodermatic syringe. The animal remained in all respects well when the bacilli of Finkler and the cheese spirilla were injected, although about fifteen minims of culture fluid was used. The same quantity of liquid, containing, in one case, a single drop of culture fluid of genuine cholera, and in a second case only half a drop, was then injected in precisely the same manner as before. Both animals promptly died, and their intestines contained an abundance of cholera bacilli, showing that rapid multiplication had taken place.

The following brief summary of Deneke's conclusions may be read with interest:

There is a group of spirilla, not widely disseminated, in which the younger individuals have a curved shape and show a tendency to form mature spirilla by juxtaposition. Several distinct kinds of spirilla belonging to this group are already known. A differentiation based merely on form is quite difficult, even with the aid of the best microscopes. With the aid of the culture method, a differentiation is much easier. Nutritive gelatine and potato constitute the best culture media for differential recognition.

Solid gelatine is fluidified slowly by Koch's cholera-bacilli, much quicker by the cheese spirilla, and with greatest energy by the Finkler microbes. As regards potato, Finkler's microbes grow and spread readily, and at comparatively low temperatures, Koch's quite slowly and only at higher temperatures, Deneke's cheese spirilla not at all. In experiments on animals, the harmlessness of all but Koch's comma-bacillus has already been alluded to. Deneke asserts that Finkler's microbe has not the slightest relation to either simple or Asiatic cholera.[1]

During the recent epidemic in Naples, Dr. Petrone[2] carried out a series of observations, which are almost completely confirmatory of the statements of Koch and his followers. Petrone's method of staining the bacteria in fresh cholera stools or vomit was as follows: A drop of the liquid to be examined was allowed to fall on the cover-glass, which was then heated in the flame of a spirit-lamp. It was then stained with a watery one per cent. solution of methylene or aniline blue, containing ten per cent. of alcohol. After twelve to forty-eight hours it was washed with alcohol, cleared with oil of cloves, and mounted in Canada balsam. With this method he has stained the characteristic fecal matter and vomit from one hundred and fifty cases of cholera, seventy cases of cholerine, and fifty of choleraic diarrhœa.

In the fecal matters from all the cases of cholera, and from the greater part of the cases of cholerine and choleraic diarrhœa, he found constantly the following bacteria: *a.* comma-bacilli of Koch; *b.* spirals, or screw-like spirilla; *c.* straight and curved rods, moniliform; *d.* spirilla, S-shaped, of identical structure with the rods; *e.* small round cocci.

He believes that the comma-bacillus is only an element of the spiral set free, and is not, therefore, in itself a true bacillus. The spirals are to be regarded as colonies of comma-bacilli. Petrone's injection of cholera matter into the stomach of animals gave negative results. Regarding the artificial cultivation of the commas he found that in milk, or raw and cooked fruits, they flourished.

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[1] From the editor's previously mentioned article published in the Medical Record, February 28, 1885.

[2] Gazzeta Medica Italiana Lombardia, November 22, 1884.

[illegible] they also grew well. [illegible] grew well if the cloth was [illegible] since the nutritive prin- [illegible] skin of animals with the [illegible] animals fed with these liquids [illegible]

[illegible] before the New York County [illegible] against the acceptance [illegible] his allegiance to the [illegible] He says:

> [illegible] doctrine has been already [illegible] diseases may be logically [illegible] statement: the question is, [illegible] comma-bacillus, or some other micro- [illegible] comma-bacillus and other [illegible] the pathogenic claims of the [illegible]
>
> [illegible] of which remains to be [illegible] to be found exclusively [illegible] cholera, the pathological con- [illegible] of the mucous membrane [illegible] lesions are either due to the [illegible] for its cultivation, in the [illegible] the lesions. Now, epidemic [illegible] disease and of rare oc- [illegible] vastly more improbable that the [illegible] than that the parasite exists prior to, [illegible]

[illegible] investigations concerning the etiology of [illegible] Dr. R. H. Fitz, Professor of Pathology in Harvard University, [illegible] statement that "the weight of the evidence thus [illegible] confirmatory of Koch's claim to the constant [illegible] micro-organisms in the intestinal [illegible] and nowhere else except in direct connection with the latter." If the comma-bacilli are specific bacteria found only with cholera, it follows directly that they are to be regarded as diagnostic of Asiatic cholera.

From an analysis of the recent literature on cholera, Dr. Fitz is finally [illegible] to formulate the following conclusions:

> 1. A well-defined characteristic organism—the comma-bacillus of Koch—is to be found in all cases of cholera, especially during the earlier stages of the disease. It is never found except in connection with cholera. 2. It is present in such [illegible] and under such circumstances as to indicate that it has an important influence in producing the symptoms and spread of the disease. 3. When introduced into the intestine of certain animals it occasions alterations of the intestine, [illegible] of the small intestine and its contents, resembling in appearance and composition those found in cholera. 4. A thorough appreciation of the properties of this organism is, therefore, essential for the early recognition of suspected cases of cholera, and especially for intelligent attempts at preventing the origin and spread of this disease.

The following conclusions published by the editor in connection with [illegible] paper on cholera, seem to him justifiable:

> [illegible] of the cholera bacillus, even more so than that of tuberculosis,

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[illegible] New York Medical Journal, October 25, 1884.

[illegible] Boston Medical and Surgical Journal, February 19 and 26, 1885.

[illegible] Medical Record, February 28, 1885.

is so entirely dependent upon the skilled use of special technical methods, but recently elaborated, that we should be surprised that the discrepancies reported by different observers are not greater than is actually the case. The concurrent testimony of a large number of writers of different nationalities is now sufficient to establish the rule that particular curved bacilli occur in Asiatic cholera.

Where positive observations are so numerous and harmonious, we may place a greater value upon them than upon the isolated negative evidences of a few experimenters. As to the presence, then, in Asiatic cholera of Koch's comma-bacillus, there can no longer be any question of fact. Its relative preponderance in the lower portion of the ileum is still somewhat doubtful. And with regard to the various stages of an attack, and the differing gravity of separate cases, some of those most competent to speak from personal knowledge are not fully in accord with Koch, who finds the presence of the commas related to them in such a way that severity indicates, *cæteris paribus*, a preponderance of bacilli, and *vice versa.*

Nevertheless, by finding and proving the identity of these microbes by the culture method of Koch, we may have a diagnostic aid that should not be ignored. It may not be often that such additional assistance will be necessary, since the clinical signs of typical cholera are well marked and well known. But it is notorious that in the absence of an epidemic, such extra aid may become absolutely necessary to elucidate a particular case.

Koch's doctrine harmonizes so well with the clinical history of cholera that it ought to be accepted as the best theory yet offered in explanation of the disease. But it should be remembered that a theory is not a scientific fact. We need more evidence and renewed experimental observation before Koch's doctrine, in its entirety, can be made to permanently stand or hopelessly fall. Many observations point to the possibility, mentioned by Koch, of the comma-bacilli producing ptomaines or similarly virulent products of vital action in the bodies of their hosts.

The great credit belonging to Koch consists in the fact that he has pointed out to us the paths along which future inquiry must go. We are to-day able, thanks to his excellent technique, to pursue bacteriological researches with much greater accuracy and definiteness than was possible even a few years ago. As with tuberculosis Koch's discovery of a distinct organism has given us clearer views, so it is likely to be with cholera.

It is true, we have not yet been able to ascertain the full truth. Future views and conceptions concerning the intimate nature of cholera may vary as much as past ones have done. But when the history of cholera shall be written, fifty years hence, it will have to be stated that Koch's discovery of the comma-bacillus constituted a decided step in advance in the pursuit of scientific truth.

CHAPTER XXV.

THE CONTAGIOUSNESS OF CHOLERA.

We have already expressed our conviction to the effect that cholera is a specific infectious disease, and, though contagious, that it is not so in the sense, for example, of the acute exanthemata. That the peculiar contagion of cholera resides in the dejections is no longer doubtful. That it is not a volatile substance emanating from the sick is also certain. It is shown by the fact that the immediate attendants upon cholera patients are less liable to contract the disease than, for example, the washerwomen and others engaged in handling the soiled linen, and than we should expect to observe if it partook of the nature of a volatile poison.

In the opinion of the editor, a practical disregard of the contagiousness of cholera (though, as previously stated, this is not as direct as in the case of small-pox and similar affections) involves, both in the presence of an epidemic and during the time of its expected arrival, graver responsibilities than we have any right to assume. Burrall[1] says truly in this connection:

> The evidence which is advanced against the contagiousness of cholera does not weaken the accumulated force of the facts in its favor, some of which do not admit of a reasonable doubt, but it only shows that the liability to contagion is diminished, or strengthened, by certain localizing causes.
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> Preconceived opinions, although honestly taken, have been in many instances an obstacle to the belief in the communicability of cholera from individual to individual, and the same result has been produced in others from a failure to appreciate the indirect manner in which the disease is believed, on good evidence, to be communicated.

It is proper to state, however, that even at the present day many physicians in India, long familiar with cholera, still doubt its specific contagiousness. Thus Dr. Morehead's observations apparently support the view of the non-spreading of cholera in hospitals through contagion. They were conducted with care through three epidemics in Bombay, and though he refrains from drawing positive conclusions, his experience is not in favor of contagion. Sir Joseph Fayrer states that he has seen hundreds of cases of sporadic and epidemic cholera, but has seen nothing to make him believe there is anything of contagion in connection with the disease. Dr. J. R. Lewis writes that for fourteen years he has studied cholera, and has never seen anything to lead him to think it contagious. It was the custom in India to treat cholera in the same wards as other diseases, and no evil resulted.

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[1] Asiatic Cholera. By F. A. Burrall, M. D. New York: W. Wood & Co., 1866.

Among those who maintain that cholera is a non-contagious disease, Dr. J. M. Cunningham, the surgeon-general and sanitary commissioner to the government of India, occupies a prominent place. His opinions, as laid down in a work that has just appeared,[1] are diametrically opposed to those of the contagionists, and especially the positive assertions of Koch and his followers as regards the etiology of this disease.

He makes this sweeping assertion concerning the doctrine of Koch: "The whole superstructure which the German Cholera Commission raised on the supposition that the comma-bacillus is an organism peculiar to cholera, and which was viewed with such ready approval both by the public and a great part of the medical profession, has in fact tumbled to the ground." Elsewhere he declares that "from the record of about 8,000 attendants on cases of cholera in India it is proved that they suffer no more than other people living in the same place. There is no danger in attendance on cholera cases." Surgeon-General Hunter, in his report on the recent cholera epidemic in Egypt, after quoting the above, adds:

> My personal experience of cholera in India is in accordance with the opinions above expressed. The professional staff, a large body of students and attendants of the Medical College and Hospital, Bombay, who were more or less in frequent communication with cases of cholera, and many of whom were also engaged from time to time in performing *post-mortem* examinations, appeared to enjoy comparative immunity from the disease without any special precautions being taken. Experience gained during the recent epidemic in Egypt confirms still further these facts. It was no uncommon thing to hear from medical officers and others that their clothing and persons had been covered with the discharges from cholera patients, which had been allowed to become dry, yet no evil results followed. Circumstances rendered it necessary that the British officers serving with the Egyptian army should attend on the cholera sick, wash the bodies after death, according to Moslem usage, and afterward bury them, and yet in no single instance, if I am correctly informed, did they contract the disease.

The Recent Discussions on Cholera before the Paris Academy of Medicine.—Allusion must here be made to the prolonged discussions which took place at many successive meetings of the Paris Academy of Medicine during the summer and fall of 1884. Two principal theories were enunciated as to the nature of cholera. M. Jules Rochard, and a majority of the members of the Academy, held to the theory of personal contagion and the importation of the disease through human intercourse and the medium of fomites. M. Jules Guérin, on the other hand, championed the cause of the believers in the spontaneous origin of cholera. Although an able orator, a learned physician, and a gentleman of unquestionable sincerity, he received but slight support from his fellow members. On the other hand his views were shared by many of those who had recently been brought into personal contact with the disease in the south of France.

In reviewing the Academy discussions, Dr. J. P. Bonnafont[2] recalls the oscillations regarding the doctrine of contagion, in the last half century.

> From 1830 to 1849 nineteen-twentieths of the physicians in France were non-contagionists. From 1850 to 1880 almost the exact opposite prevailed. And in 1884 he states that there were as many or more non-contagionists as believers in contagion, and the indications were that the pendulum would soon swing well

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[1] Cholera: What can the State do to Prevent it? By J. M. Cunningham, M.D., Surgeon-General Indian Medical Department, and Sanitary Commissioner with the Government of India. Calcutta, 1884.

[2] Le Choléra devant l'Académie de Médecine. La Contagiosité et les Quarantaines. Paris: J. B. Baillière et Fils. 1885.

over to the negative side. The contagionists of late years have attempted to effect a sort of compromise with their opponents by maintaining that there are two kinds of cholera—one contagious, the imported or Asiatic cholera; the other non-contagious, sporadic cholera, or as Fauvel called it, cholera nostras. This new doctrine is the one which seemed to be most in favor among the members of the Academy of Medicine. At the beginning of the epidemic M. Fauvel, in an endeavor to calm the excited fears of the public, declared before the Academy that the disease was of the sporadic variety,and was consequently not contagious, and would remain limited to the two cities in which it then was. But when the disease passed the bounds set for it by M. Fauvel, MM. Brouardel and Proust were dispatched by the Minister of Commerce, and M. Rochard by the Minister of Marine, to study the progress and the character of the disease. These three reported, contrary to the opinion put forth by M. Fauvel, that the epidemic was one presenting all the characteristics of Asiatic cholera, and that the disease was therefore highly contagious. The first, while avowing that quarantine alone could hinder the spread of the disease, stated squarely that it was impossible to maintain a quarantine by land. There were then two opposite systems in force—one on the side of the sea condemning the unfortunate travelers to a long period of detention; the other on land allowing the inhabitants of the infected districts to go forth freely, sowing the epidemic along their route, without fear of the bullets of the sanitary guards.

The advocates of the spontaneous theory, who believe that cholera may arise and be propagated in any locality without being contagious, assert also that the atmosphere may undergo changes rendering it capable of producing the disease. But they believe that the air is always the medium of transmission, and on this point they are in accord with some partisans of the importation theory. It is very evident, M. Bonnafont asserts, that the air is the only vehicle which can transport to great distances from its point of origin any infectious principle whatever; but it could never be the generator of this principle. In support of this assertion that it is possible for the contagion to be transported through great distances by the air, he mentions the carrying of the ashes thrown out by the recent volcanic eruption in Java.

M. Jules Guérin supported the doctrine of the spontaneous origin of cholera, maintaining that it can originate and be reproduced in any country whatever. And M. Bonnafont agrees with him in so far as he denies the contagiousness of the disease, citing numerous facts and authorities in his support. He asserts that "the transmission of cholera from one individual to another is scientifically impossible." And he asks how it is possible to believe that one person can introduce the disease into a previously healthy district, when, as in the hospital of the military school at Constantinople, in 1855, nearly 1,500 cholera patients were treated during the course of a year, and not one of the attendants suffered from the first symptom of the disease. He quotes M. Cazalas as asserting most emphatically that cholera, which is contracted by infection in a cholera district just as intermittent fever is contracted by infection in a malarious region, is neither directly nor indirectly contagious. M. Bonnafont concludes his monograph by the statement that he opposes most strenuously every form of quarantine as useless, since, as he believes, the atmosphere is the sole vehicle for the transmission of the cholera poison, and the air cannot be made subject to quarantine regulations.

Gocdeve's Opinion.—Goodeve, an English writer of large experience in India, says:

> A volatile poison, at all strong in its action, would be most dangerous to all about the sick, and yet in India the medical men, nurses, hospital coolies, sweepers, and others who are constantly engaged about the sick do not appear to be more liable than the rest of the population. The disease seldom spreads from bed to bed in a ward; on the contrary, when people are attacked in hospital they lie generally in a distant corner, or in another ward. I have noticed this over and over again, and though I have been connected with the larger hospital of the medical college at Calcutta for many years, I do not recollect any spreading to the nearest or neighboring patients. I should, as far as my own experience goes, say that cholera does not spread from the sick to the whole by any rapidly acting emanation.

Other Views.—Against the foregoing and many similar statements from far less competent writers, we have the positive evidence of a large number of accurate observers. Only a few illustrations in point are here introduced.

From the epidemic of 1861 the India commission found that for the whole of the troops attacked in thirteen stations, the "virulence of the disease among hospital patients was clearly more than twice as great as it was among the healthy strength of the regiments."

Writing in 1866, Burrall states that

> The opinion of physicians in Europe has been tending toward a belief in the contagious nature of cholera. During the last epidemic in Paris, the cholera patients were treated in separate wards, and the administration ordered the immediate removal, cleansing and disinfection of the bedding used by cholera patients, as well as the washing and fumigation of the personal clothing.
>
> M. Velpeau considers the contagious character of the disease proved to a certainty, and the same is true of other prominent European physicians.

The views of M. Jules Worms,[1] who has had a very large personal experience with cholera, may also be cited in this connection. He stated at a meeting of the Paris Academy of Medicine that

> On the banks of the Ganges, and under conditions which are not well understood, a special agent, poisonous to a large number of individuals, is produced. This agent shows itself among individuals who are collected together in rest or motion, but always presents an uninterrupted connection. The cholera is a malady transmissible by man. This agent manifests its influence on certain human beings (probably also on certain animals) by mild or severe effects. The proportion of individuals liable to the poison can only be approximately estimated, and is under all circumstances very small. The human system may become a fruitful field for the multiplication of this agent as soon as its poisonous effects are manifested. The multiplication of this poisonous agent takes place chiefly in the alimentary canal. The vomitings and dejections of cholera patients contain the active agent of the transmission of the disease. This communicability does not correspond to the time when the dejections are voided, but is developed a few days subsequently, and seems to be exhausted at the end of from fifteen days to three weeks. The corpses of cholera patients emit the toxic agent in a greater degree than the bodies of the sick. Persons attacked merely with choleraic diarrhœa (cholerine) void with their dejections the agent which is capable of producing confirmed cholera in their vicinity. The greater or less density of the soil on which the dejections are cast diminishes or favors the propagation of the disease.

The late lamented Dr. Elisha Harris,[2] in 1865 made the following statements embodying his experience at the Staten Island quarantine, with regard to the contagiousness of choleraic dejections:

> In studying the history of fourteen epidemics of cholera that have occurred within the walls of our New York quarantine establishment, the writer has seen abundant evidence of the *infectious agency of the sick and their "rice-water" evacuations.* Ten of these epidemics at Quarantine unquestionably depended upon cholera patients from ships, and in six instances, at a time when there was no cholera upon our Atlantic coast. These sudden outbursts of cholera, as a general rule, occurred within a period of four days from the disembarkation of the sick; and whenever cholera was not generally epidemic in this country, these epidemics at Quarantine ceased as suddenly as they came, after sweeping off a portion of the convalescents and patients that were in other hospital buildings, having other diseases. The cholera patients were kept as remote from other patients as possible.
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> Concerning these repeated outbreaks of cholera at Quarantine, it should be stated, that while they prove how fatally infectious the cholera poison may become in the midst of crowded hospitals and public institutions, they utterly failed

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[1] Archives générales de Médecine, Nov., 1865, p. 623.

[2] Report on Epidemic Cholera by the Council of Hygiene and Public Health of the Citizens' Association of New York. New York, November, 1865.

to prove that from the same exclusive cause—viz., the contagion of the cholera evacuations—a world-wide epidemic could be caused. These outbreaks did prove, however, that the stools and besmeared clothing of the sick with cholera can, under certain circumstances, propagate the disease; while, on the other hand, a series of events at Quarantine and in the city demonstrated that, for the production of a wide-spread epidemic, other important causes than the presence of the "rice-water" stools and vomitings must be present.

Dr. Budd[1] has also collected a number of instances in which the spread of cholera was apparently prevented by an immediate disinfection of the discharges. Some of these instances are here reproduced:

> Immediate disinfection was tried, at his suggestion, in the year 1854, at Fishponds, in the workhouse situated there for the reception of the Bristol poor. In 1849, cholera, brought in by a woman coming from an infected quarter in Bristol, killed, in this same workhouse, more than 130 out of less than 600 inmates.
>
> In 1854, although the pest was introduced into the workhouse three separate times, only eight died of it, and the total number of attacks was under thirty.
>
> In the prison of Kaisheim cholera was introduced by a prisoner who died there. The sanitary conditions of the prison were as bad as possible, but the choleraic discharges were disinfected, and the result was, that only one of the 500 other prisoners took the disease. In the prison of Elrach, on the contrary, where no measures of this kind were taken, of 350 prisoners, fifteen per cent. perished.
>
> At Traunstein, in Bavaria, in every case in which the rice-water discharges were disinfected the disease ceased with the person first seized.
>
> In conclusion, he mentions the case of a planter in the Island of St. Vincent, who ascribes the almost entire escape of his laborers from cholera in the great epidemic of 1853 to similar measures. When cholera broke out on his estate, he encamped all his negroes on open ground, and by the advice of one of his friends, had a pit dug in the earth and deeply charged with chloride of lime, to serve as a receptacle for all discharges from the sick. The result was, that while the neighboring estates were all decimated by cholera, and some almost depopulated by it, this gentleman's estate escaped with only a slight outbreak.

Lebert's views are very much in accordance with our own conceptions concerning the point under consideration. He has found many examples showing rapid contagion by means of fresh excretions. The manner in which cholera attacks those who come in contact with patients, their discharges, linen, or dead bodies is, he explains, quite in harmony with the parasitic doctrine. He says:

> I have noticed in all epidemics, and have seen it mentioned in the writings of many authors, that practicing physicians, even hospital physicians, are seldom attacked with cholera, because, although they come in contact with many patients, their stay with each is short, and because, when themselves attacked, they immediately treat the prodromic diarrhœa. But the resident physicians, and more especially the assistants and nurses, are much more frequently attacked. Their contact with the sick is much more protracted, and not unfrequently local epidemics are developed in hospitals which effect transient visitors rarely or but slightly, while residents, or those whose stay is longer, are attacked much more frequently and intensely.

Finally he gives the following unequivocal expression to his convictions:

> The much-agitated question concerning the *contagion* of cholera, whether, if it be considered contagious, it is spread by a miasma or contagium, must be considered, under the light we now possess, as follows: That cholera can be spread only by contagion, *i.e.*, by germs which are carried from a diseased to a healthy person; but that these disease germs infect only comparatively rarely by intercourse or contact with cholera patients, since they possess relatively but little vitality in the air of the sick room, and are present mostly in inconsiderable quantity. On the other hand, a certain number of the germs and a given vitality

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[1] Memoranda on Asiatic Cholera; its Mode of Spreading and its Prevention. By William Budd, M.D., etc. Bristol, 1865.

> are necessary for the propagation of the disease, and these conditions are better met in fluids than in the air; hence contagion is more frequent when the germs are communicated through a fluid than when transmitted through the air. Should the germs of cholera excretions fall into a privy, for instance, and from here find their way by filtration into drinking-water or subterraneous habitations, the individuals who had appropriated the most germs would suffer most severely. The danger of contagion in cholera, therefore, is relatively less from direct contact with cholera patients than from frequent contact with the insidious and latent germs proliferated from these patients. As these germs are more or less confined to their localities of origin, and as they develop more especially in fluids, the water of the soil and drinking-water must play an important, although not an exclusive, rôle as vehicles; cholera excretions, too, are the frequent though by no means the sole carriers of the germs; indeed they may even lack every element of contagion. We are justified at the present day in attaching but little etiological value to the idea that cholera may spread its contagion to great distances under certain conditions of the atmosphere and with certain winds.

In his recent article on cholera, Stillé is even more emphatic. He says:

> It is sometimes said, and oftentimes repeated, that cholera is not directly contagious—is not communicated by the sick to the well. No statement could be more unfounded. The whole history of cholera proves that the physicians and nurses of cholera patients are often affected by the disease.

Griesinger, in his excellent treatise on the infectious diseases,[1] has also collected some striking evidence touching the communicability of cholera, of which the following is a summary.

The spread of cholera through the agency of patients suffering from the disease seems in many cases very evident. A little community of individuals, as a household, or the inmates of a public institution, of a hospital or of a single ward of a hospital, may have been free from an invasion of the disease during the prevalence of an epidemic. Now one or more cholera patients are introduced, whereupon suddenly several of the community will be seized with the fatal malady. Among the most striking instances of this sort are those related by Magoun as occurring in the hospital at Kieff, by Ebers in Breslau, by Briquet in Paris, by Haller and Dittel at Vienna. Gietl states that of the 326 cases of cholera treated in the city hospital at Munich in 1836–7, 106, or 32 per cent., acquired the disease in the institution. In the epidemic at Paris in 1853–4, one-third of the cases treated in the hospitals were attacked there (Gazette Hebdomadaire, 1854, p. 410). And indeed in the first half of March, 1854, of the 55 cases treated at the Charité, 48 began in the hospital. J. Reuss states that in Strasbourg in 1849, 7 per cent. of the hospital population were attacked with cholera, while the rate in the city was only a little over ¼ per cent; and in 1854 there was again a rate of 7 per cent. attacked in the hospital and only ¾ per cent. in the city outside. Concerning the Vienna hospital in 1854, C. Haller says: "As a rule one case of the disease was always followed by several, and sometimes by very many, in the same ward."

It might seem that these instances proved little in regard to personal contagion, since they occurred during the prevalence of an epidemic, and among individuals exposed to unfavorable influences from hospital air and overcrowding. But on the one hand the general population lived under much more unfavorable conditions; and on the other the new cases often broke out, not in the most crowded and unhealthy, but in the best ventilated wards. The disease broke out only after cholera patients had been received, and then spread step by step from the beds and wards where they were, stopped when no more patients were received, and began again upon the advent of new cases from without. On the other hand, in places where there were special hospitals for cholera patients, the general hospitals, the Berlin Charité for example, did not suffer especially. The influence of fright may be excluded from the fact that in many cases small children and unconscious typhoid patients were attacked.

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[1] Infections-Krankheiten von Professor Griesinger. in Virchow's Handbuch der Spec. Pathologie und Therapie. Erlangen, 1864.

In some cases medical attendants in hospitals appear to enjoy a considerable degree of immunity from cholera, but on the other hand not a few instances are on record of exactly the opposite. The following additional illustrations, showing this occasional danger to medical men, are also furnished by Griesinger. In Moscow in 1830, from 30 to 40 per cent. of the hospital *personnel* suffered from cholera, while the rate in the city was only 3 per cent. (Jaehnichen). In Romberg's cholera hospital in Berlin, in 1831, of 115 employees in the institution, 54 had the disease; and in 1837, of 65 to 70 nurses, 14 (one-fifth) suffered, and at one time 7 were attacked within twenty-four hours. In the Charité at Paris, in 1849, every sixth man among the employees was attacked, while the proportion in the general population of the city was only one in twenty-five. In Milan, in 1848, 8 out of the 16 physicians suffered from cholera. At Toulon in 1832, in the marine hospital, 10 out of 35 of the medical staff had the disease, and 5 died; and in the military hospital the ratio was 8 to 32; and of the 30 laborers who handled the dead bodies, 10 died within a few days (Renaud). In Stockholm, in 1853, of the 536 persons concerned with the care of the sick, every eighth one had the disease and every sixteenth died. In Carlscrona, 1 in 5 of the nurses was attacked and 1 in 9 died (Wistrard). In the Vienna hospital in 1854, of 36 nurses, 7 suffered from cholera (2 died), 3 had diarrhœa with typhoid symptoms, and 3 had cholerine; and of 7 laborers who carried the patients, every one suffered from a debilitating diarrhœa lasting from 3 to 8 days (C. Haller). In the Strasbourg hospital in 1849, 5 of the 10 nurses were attacked, and in 1854, 3 out of 10 (Reuss). These figures show that at times the sickness of the medical *personnel* is not inconsiderable. The variations in the proportion of hospital attendants attacked were due to the different degrees of cleanliness observed. Sometimes great care was observed in quickly removing and disinfecting the intestinal discharges, and at other times great laxity prevailed in this regard. But it is not surprising that the physicians are less liable to suffer than are the nurses and the other patients, since the former remain but a short time with the sick and have nothing to do with the discharges, or at least examine them only in a fresh state. The same fact is observed in typhoid fever, that the medical attendants are much less likely to suffer than are the patients living in the same ward with the typhoid patients.

Again, from a study of the observations recently made in the French epidemics, Dr. H. Mireur[1] formulates the following propositions concerning the contagiousness of cholera:

1. Cholera is not transmitted directly from the sick to the well either by contact or through the respiratory passages. 2. The products emanating from cholera patients, the dejections and vomited matters, contain a germ which is not immediately transmissible by itself, but which, placed under favoring conditions, gives rise to a contagious principle—the cholerigenous

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[1] Op. cit., p. 154.

principle. 3. The contagion of cholera is never operative but through this principle, either through the medium of the atmosphere or of water: 4. Clothing and merchandize, much more than individuals, are the agents for the transportation of this principle. 5. The cholerigenous principle is implanted only in those natures in some sort prepared to receive it; and it produces either cholera or cholerine according as the soil which it meets is more or less favorable for its development; when the soil is unfavorable no result is produced.

This subject is sufficiently important to warrant the introduction of the following additional evidence, illustrating the point in question.

According to Read—

> In Constantinople no less than twenty-seven physicians and medical assistants were attacked and died during their attendance on cholera patients; and in Paris and Toulon similar results followed. At Halifax, N. S., two of the physicians who volunteered in aid of the steamer England, which put in there disabled by the ravages of cholera among the officers and crew, as well as among the steerage passengers, took the disease, and one died.

Again:

> Of one hundred and thirty-nine physicians engaged in attending cholera patients in Naples under the White Cross Society, twenty died.

From the London Hospital Reports, vol. iii., we learn that

> In 1832 the cases of cholera in Edinburgh were in the proportion of 1 to every 1,200 of the population of the city, while among those in attendance upon the sick the proportion was 1 to 5. In 1848–49 one-fourth of the nurses employed in the cholera hospital took the disease, while in the general hospital, only a few paces distant, where no cholera patients were received, not a single attendant was attacked. In the London Hospital, in 1866, none of the medical officers, volunteer nurses, or sisters were attacked. Of the (regular) nurses, five contracted the disease, and of these four died.

Stillé also alludes to the severe and fatal epidemic which in 1849 broke out in the Philadelphia Almshouse:[1]

> The resident physicians of the hospital were abundantly occupied with the care of the sick of other diseases, and it was thought prudent not to allow any, even an indirect, communication between them and the cholera patients. The latter were therefore removed to an isolated building in the middle of the quadrangle, and attended by physicians from the city who had volunteered their aid. Three or four of these physicians had attacks of cholera, and two of them died. At this time there was no cholera at all in the city, and the young physicians could not have become infected outside of the almshouse. They were attacked while attending the sick of cholera, but the regular house physicians, who seldom visited the cholera patients, escaped altogether.

In an able article on the germ theory of zymotic diseases, Dr. W. B. Carpenter[2] makes some comments that may also prove of interest in this connection. He says:

> The conditions of the spread of typhoid or enteric fever are closely analogous to those of the diffusion of cholera; and the doctrine of disease-germs proves as satisfactorily applicable to the one case as to the other.
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> But because typhoid germs, when introduced into the human system, breed and multiply within it, and, when voided from the intestine, may be conveyed by the water into which they have found their way into the bodies of other persons, who then become the subjects of the disease, it by no means follows that the human body is their *only* breeding-ground, or that water is their *only* vehicle. On the contrary, those who have most carefully studied the subject are now generally

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[1] Philadelphia Medical Examiner, November, 1849.

[2] The Nineteenth Century, February 1884.

> agreed, that when typhoid germs have been discharged into sewers, they not only infect their contents, but so develop themselves under favoring conditions (especially warmth, stagnation, and seclusion from the air) as to give rise to an enormous increase of the *contagium*. And in the case of the wide diffusion of typhoid poison by milk, it seems far more probable that the germs introduced by the contaminated water used in washing the milk-vessels have multiplied by self-development in the milk put into them, than that they should have originally been abundant enough to communicate the disease to so large a number of individuals as are in some instances attacked by it.

He sums up his opinions touching the contagion of cholera in the following way:

> On the whole, then, the conclusion seems clear, that while the breeding ground of ordinary malarious germs is the earth alone, and the breeding ground of the germs of the ordinary exanthemata is the human body alone, there is an intermediate class of pestilential diseases—including cholera, typhoid, and probably yellow fever—in which (as Mr. Simon[1] tersely expressed it) "certain microphytes are capable of thriving equally, though perhaps in different forms, either within or without the animal body; now fructifying in soil or waters of appropriate quality, and now the self-multiplying *contagium* of a bodily disease."

But although, as has been shown, the evidence in favor of supposing that cholera does not enter the human system through the respiratory passages is decidedly strong, and although it is reasonable to believe that the specific infection must always occur through the alimentary canal, Carpenter nevertheless holds that a primary introduction of disease-germs into the lungs may occur in cholera. He says:

> The doctrine that the disease-germs of cholera and typhus breed in the human intestine *only*, and that they are introduced into it by water *alone*, obviously sets at naught a large proportion of those precautionary measures on which those who are most practically conversant with the subject lay great stress. Everything ought unquestionably to be done to preserve our domestic water-supply from contamination, as well as to secure the purity of its sources; and to disinfect not only the intestinal *dejecta* of patients affected with cholera or typhoid, but everything contaminated by them. But we ought not, in doing these things, to leave others undone; and all experience justifies the emphatic warning of the Local Government Board, as to the danger of breathing air which is foul with effluvia from the same sorts of impurity—a danger whose source obviously lies in the *atmospheric* transportation of disease-germs.

There are obvious objections to the acceptance of these views, in so far as they relate to aerial infection. In the first place neither Koch's bacilli nor any other bacteria, barring the ordinary atmospheric-microbes, are discoverable in the lungs of cholera-bodies.

Again, even supposing that through a contaminated and germ-carrying atmosphere a deposition of microbes occurs in the upper air passages, they may nevertheless be carried into the alimentary canal through deglutition. And finally it should never be forgotten that the primary lesions of cholera are intestinal, and not pulmonary. So that whatever potency we may wish to ascribe to foul air as a predisposing factor in the production of cholera, we must insist that the actual infection has not been shown to take place through the respiratory channels.

Surgeon-General Murray,[2] who served for many years (38) in India, ordered about 500 circulars to be sent to the local governments and their medical officers. From the returns thus received it became evident that there was an almost unanimous belief in the communicability of cholera.

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[1] Article "Contagion" in Quain's Dictionary of Medicine.

[2] The Practitioner, vol. xix.

Those who believed in a spread from person to person amounted to 75 per cent. of the whole number; from place to place, 85 per cent.; by the evacuations, 92 per cent.; and by clothing, as many as 98 per cent.

In our own country the history of the epidemic in 1873 furnishes a multiplicity of examples, illustrating the contagious character of Asiatic cholera. But it is not intended to weary the reader with further details. In the light of previous experience, in the light of recent researches, in the light of the matured opinions of the majority of accurate observers, we must proclaim the contagiousness of epidemic cholera. And it may be proper to point out that in this respect, if in no other, the disease differs radically and completely from its symptomatic ally cholera-morbus.

CHAPTER XXVI.

CONDITIONS WHICH FAVOR THE ORIGIN AND DISSEMINATION OF CHOLERA.

It seems necessary to state explicitly that whether we accept the doctrine of the parasitic origin of cholera or not, we must still recognize certain secondary causes favorable to its breaking out and propagation. It will be our duty now to examine some of these favoring conditions, which are much less in dispute than the immediate exciting cause of the disease, although writers are by no means agreed in ascribing the same amount of potency to the different agencies in question.

The whole history of cholera shows it to be emphatically a disease spread by human intercourse. It does not travel quicker by land or water than man. Nor does it spread in directions unknown to commercial or military movements.

On land it has usually crept from place to place, and if sometimes it has seemed to leap across wide spaces, and even seas and oceans, it has never invaded any inland town or seaport without having been brought thither from a point already affected with the disease. Nor, having once entered an inland or seaboard town, does it spread equally therein in all directions, but prevails chiefly in the quarter immediately surrounding the place of its entrance. If appropriate sanitary measures are enforced, it is sometimes confined to that quarter, and, in the case of quarantine stations, it has repeatedly been prevented from extending beyond them. This statement may be illustrated by the fact that of fourteen epidemics of cholera at Staten Island, the quarantine station of New York, all but four were prevented from reaching that city.[1] When the disease does overleap the barrier opposed to it, its origin and subsequent course can usually be traced (Stillé).

It goes without saying that the individual may become more or less predisposed through his circumstances in life, his personal habits, and his surroundings. But the causes operative in this respect are the same deleterious influences favoring the acquisition of all other infectious and preventable diseases.

Poverty, with its incidental conditions of bad air, filth, overcrowding, intemperance and other excesses, doubtless favor the acquisition of cholera, but acting independently of the specific poison of the disease, they are utterly impotent. The relative mortality from cholera is, therefore, not more excessive among the poor and shiftless than that of other diseases fostered by unhygienic living and the weakening effects of insufficient or improper food and air.

As regards the **sex** of individuals, it does not seem that one is more liable to take cholera than the other.

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[1] Peters' Notes, 2d ed., p. 94.

Age is of greater importance than sex. The liability to fatal attacks increases after 45 in a very decided manner. In England, according to Gull, the greatest fatality occurred under one year and over fifty-five. The liability to contract the disease appears to be greatest between the ages of 15 and 40, and it is noteworthy that the relative mortality is the slightest for about the same period. Infants under one year of age are not specially prone to acquire cholera, but when they do take the disease, the result is almost invariably fatal.

Occupation does not appear to influence the liability to cholera. In a general way, of course, unhealthy and very fatiguing work by weakening the system renders it more liable to the inroads of disease. But this does not apply especially to cholera.

Habits, as already intimated, may influence the susceptibility to cholera in a more or less pronounced way. It is held by writers that habitual drunkards, before the stage of organic visceral changes, are no more prone to the disease than the temperate. Indeed, it is supposed by some authors that habitual drunkards belonging to the better classes enjoy a relative immunity from the disease, on account of their avoidance of water that may have become contaminated. The weight of evidence, however, favors the opinion that alcoholic drinks may assist the production of cholera.

It was found that during the cholera epidemic of 1848–9 in England the deaths from cholera on Saturday, Monday, Tuesday and Wednesday were above, and on Thursday, Friday and Sunday, below the average. The weekly wages are generally paid on the Saturdays, and the Mondays in London and other cities are days on which a certain proportion of the population indulge in intoxicating drinks. During the epidemic of 1865 the mortality in Berlin suddenly rose on certain days, and was clearly referable to excess in drinking. In 1866, Dr. Andrew Clark stated, in respect to the London Hospital, that immediately after pay-day among workmen there was a great influx of cholera patients. When the epidemic of cholera broke out at Naples in the beginning of September, the Pungola, a Neapolitan newspaper, attributed the increased number of cases to intemperate living on the 31st of August, which was a *fête* day (Chapman).

In an interesting article on the germ-theory of zymotic diseases, Dr. W. B. Carpenter[1] makes the following allusion to alcoholic excesses:

> The experience of cholera-epidemics has presented numerous examples which testify to the evil results of intemperance; but I know of no case in which the benefits of extreme temperance, in keeping at bay the operation of a zymotic poison, were more remarkable than in the contrast between the march of the 84th Regiment (of which Dr. E. Parkes was at that time assistant-surgeon) from Madras to Secunderabad, in 1847, and the concurrent march of the 63d Regiment from Secunderabad to Madras. The former had been previously quartered for several months in healthy barracks; a large number of men were total abstainers, while the rest were very temperate; and their death-rate had been no more than 12.1 in 1,000 per annum. The latter had been overcrowded in the barracks at Secunderabad; though not specially intemperate, they habitually indulged in alcoholics, and their death-rate had been 78.8. The two marches were made at the same time, in opposite directions, in a very wet and unhealthy season, through a country infested with cholera and fever; and while the 84th was almost entirely free from these diseases, the 63d had so many sick when the two regiments crossed on the road, as to be obliged to borrow the 84th's sick-palanquins.
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> Now since, in both these cases, the infecting cause must have operated alike on all, it is clear that in whatever way the cholera-germs are received into the human body, it is on the previous condition of each individual that their potency depends, and that this condition is induced by any causes which engender in this circulating fluid a suitable *pabulum* for their growth and multiplication.

Dissolute habits generally, venereal excesses, uncleanliness, do not apparently invite cholera in a more marked degree than they do other diseases. But their pernicious influences on the mortality of those attacked is undoubted.

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[1] Nineteenth Century Review. February, 1884.

Dr. McClellan says in this connection:[1]

> During an epidemic of cholera, it is particularly those whose systems are irritated by other diseases; those who are suffering from depression of the nervous forces from any cause, but especially that which attends excessive fatigue, fear, or debauches; those who live in open violation of all hygienic law; those impoverished by want, who are especially liable to the disease.

And again:

> The system of a healthy person may resist the invasion of the disease, but these individuals have nothing to resist with, and therefore succumb.

Writing on the same subject, Drs. E. and A. B. Whitney[2] remark that:

> The exhalations from low, moist, and marshy localities, from the offensive cesspools, water-closets, sinks, sewers, and the decomposition of animal and vegetable substances, from the refuse or garbage which so often befouls the sidewalks and gutters of streets, are all effective, predisposing causes that directly facilitate the production of the cholera. Whatever tends to depress the vital powers, impair normal action, or relax in any degree the tone of the nervous system, favors the operation of the final cause. So, too, the low, underground, damp, unventilated apartments, the crowded and uncleanly tenement houses, in which multitudes of the poorer classes live in a confined, foul and noisome atmosphere, not only favor but actually invite the active operation of the infecting agent. Habits of intemperance, profligacy, impurity and late hours have a powerful influence to depress and prepare the system for an invasion of the disease in its most malignant form.

The **Previous Health** of individuals influences the mortality of an actual attack more decidedly than the liability to contract the disease in the first place. Nevertheless it is obvious that all debilitating affections must create a certain amount of predisposition to cholera. Gastro-intestinal disorders are particularly liable to invite an attack. On the other hand, the strong and robust are just as susceptible to cholera as those of weaker constitution, unless the weakness have resulted from actual disease.

Acclimatization seems to play a rôle in the acquisition of cholera. As a general thing those inured to the variations of a particular climate are less apt to fall sick than the unacclimatized. Concerning residence in India, however, Goodeve says: "It has been thought that Europeans of short residence in India were more liable to suffer than those of long residence, but the opinion does not seem to have been formed upon any well-ascertained facts. The committee on the epidemic of 1861 investigated the matter for that outbreak, but they consider their data too imperfect for forming opinions." Goodeve does not believe the influence exercised by length of residence in India to be an important element in establishing either predisposition or immunity.

But Fauvel[3] has pointed out that in the East Indian towns where cholera is always endemic, the natives never die in consequence of epidemic cholera. Strangers and pilgrims may, however, be carried away in large numbers by the appearance of the disease among them. The epidemic character of an outbreak in any country shows that the disease is not endemic there.

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[1] Cholera Epidemic of 1873 in the United States, Washington, 1875, p. 47.

[2] Asiatic Cholera: A treatise on its origin, pathology, treatment and cure. By E. Whitney, M.D., and A. B. Whitney, M.D., New York. M. W. Dodd, 1866.

[3] Bulletin de l'Académie des Sciences, 1883.

Psychical influences are of unquestionable importance in favoring an attack of cholera. Nervousness, anxiety, depression of spirits, grief, fear, violent emotions, and even actual insanity would all appear to predispose the individual to contract the disease. Dr. Forbes Winslow has said that, *cæteris paribus*, the patient who has the least fear of dying during an attack of cholera has the best chance of living.

Apart from these individual factors, there are a number of other circumstances that appear to facilitate the production and propogation of cholera.

Yet once more it must be repeated that, while they may impart energy to the virulence of the disease and favor its rapid spread, they have not the slightest power to produce cholera independently of the existence of its specific poison.

General Atmospheric Conditions.—Cholera may prevail under very wide ranges of temperature, humidity and barometric pressure. Nevertheless a certain amount of heat, a high atmospheric pressure, and moderate humidity appear to favor the disease. In India cholera is at its worst during the hottest months, and there appears in this respect but little difference between dry and wet heat.

In Calcutta, however, Lewis and Cunningham did not find that temperature exerts any influence on the variations in the prevalence of cholera, except in a subordinate way. For maximum, minimum and medium prevalence were observed by them in an almost unaltered temperature.

In England (in 1848–49) the highest mortality occurred in September. But in continental Europe cholera prevailed extensively during the cold weather of the same year.

The association of heat with moisture certainly favors the spread of cholera. For example, Thom. in his report of the violent outbreak at Kurrachee, states that there was a very high dew point (83°), and a temperature of 90° F. in the shade. This led to a sense of languor and oppression, stifled breathing, and great fatigue on slight exertion.

Goodeve states that:

> A warm, moist, stagnant atmosphere in Bengal, at any time of the year, is often followed by sporadic cases of cholera, or by an increase of cases where the disease is endemic. Cholera has been known to cease after heavy falls of rain, and, on the other hand, to set in immediately afterward, as in the Meerut jail in 1861. In considering the influence of rain, we must recollect the temperature prevailing and the time that has elapsed after the said fall. A very few hours after a fall of even heavy rain, if there be no wind, is sufficient to produce just the stagnant, hot and moist atmosphere which is so oppressive to the feelings, and favors so much the spread of cholera. One must not be misled by the name of dry months. The hot months in Calcutta are called the dry months, and are, indeed, the driest of the year, yet a great deal of moisture exists dissolved in the warm atmosphere.

Lewis and Cunningham, who have made quite an elaborate study of the physical phenomena of India in relation to cholera, report that there is a certain amount of coincidence between diminished humidity and increased cholera prevalence in Calcutta. They say:

> We have maximum prevalence and minimum humidity in March; and minimum prevalence and maximum humidity in August.

With especial reference to the influence of rainfall, these observers state that there is

> nothing to justify the belief that rainfall in Calcutta exerts any direct action either

in producing or diffusing the essential cause of cholera; but, on the other hand, there is some evidence that excessive rainfall exerts a directly opposite action.

It is proper to point out in this connection that moisture and heat favor the growth and development of the comma-bacilli. And further that a heavy rainfall may so dilute contaminated pools and wells as to lessen the chances of infection. Still it should not be forgotten that cholera has been known to speedily follow a severe thunder-storm.

The cessation of autumn epidemics of cholera on the approach of winter is a well-established fact. Nevertheless the disease may survive even a very cold winter, as has been several times observed. Cold does not kill the bacilli of cholera, although it appears to hinder their active proliferation.

Hirsch has found from a study of 341 outbreaks in different countries, that cholera has appeared in nearly half of all the epidemics during the summer, and chiefly in July and August. Winter is characterized by an unmistakable exemption from the disease.

Electricity, Ozone and Cosmical Influences.—In spite of the very positive assertions of some writers, it does not appear that either of these factors, or all combined, are decidedly influential in promoting the spread of cholera. But to deny them all potency for assisting the disease would be to err on the other side.

Mr. Glaisher has made a number of interesting observations touching these points, which are found in the appendix to the Cholera Report for 1853–54, and in the report of the Indian Sanitary Commission (1862).

In his report on the Meteorology of London during the three cholera epidemics of 1832, of 1848–9, and of 1853–4, he found that they were attended with a particular state of atmosphere, characterized by a prevalent mist, thin in high places, dense in low, during the height of the epidemic. In all cases the reading of the barometer was remarkably high, and the atmosphere thick.

In 1849 and 1854 the temperature was above its average, and a total absence of rain and a stillness of air amounting almost to calm accompanied the progress on each occasion. In places near the river the night temperatures were high with small diurnal range, a dense torpid mist, and the air charged with many impurities arising from the exhalations of the river and adjoining marshes, a deficiency of electricity, and, as shown in 1854, a total absence of ozone, most probably destroyed by the decomposition of organic matter with which the air in these situations is strongly charged.

In 1849 and 1854 the first decline of the disease was marked by a decrease in the readings of the barometer and in the temperature of the air and water; the air, which previously for a long time had continued calm, was succeeded by a strong southwest wind which soon dissipated the former stagnant and poisonous atmosphere. In both periods at the end of September the temperature of the Thames fell below 60°; but in 1854 the barometer again increased, the air became again stagnant, and the decline of the disease was considerably checked. It continued, however, to subside, although the months of November and December were nearly as misty as that of September.

Soil.—It has not been conclusively shown, although there are very positive assertions to the contrary, that the nature of the soil has any very decided influence on the appearance and spread of cholera. But to deny this factor all importance would be to err in an opposite direction. According to McClellan, stiff and clayey soils have shown a higher mortality than loose, sandy and easily drainable ground. Farr said that cholera was less fatal in England on primary geological formations than on others. Black cotton soil was found to exist in nearly half the epidemics examined by Lorimer (Goodeve).

Lewis and Cunningham hold that obstructed ventilation of the soil favors cholera. They say that

> the theory of cholera which regards conditions of the soil as essentially determining the production of the cause of cholera in a locality is much more in accordance with the phenomena of its seasonal prevalence, as manifested throughout the Bengal Presidency, than any of the other doctrines appear to be.

Aitken states that

> although very great differences of opinion thus prevail as to the part which obvious local causes bear to the production or spread of cholera, yet it is almost universally considered that they are necessary for the development and propagation of this disease in its epidemic forms.

For an analysis of Pettenkofer's views regarding the rôle played by soil and subsoil water in cholera, the reader is referred to p. 319.

Lebert has pointed out that:

> The geological structure of the soil has of itself but little influence upon the disease, for, since Pettenkofer's reports, it is admitted that it is the physical rather than the mineralogical structure which most concerns cholera. Porous soils, which permit the penetration of moisture and fluids, especially facilitate the diffusion of cholera; while a rocky, solid subsoil, immediately beneath the surface, is much less suitable. But the porous condition alone is not effective when it reaches to a certain depth, or when the fluids traverse the soil so quickly that they cannot form localized accumulations.

Elevation above Sea Level.—Lowness of site, all the world over, favors the appearance of cholera. Farr says concerning London that the elevation of the soil has a more constant relation with the mortality of the disease than any other known element. He asserts that the mortality is in the inverse ratio of the elevation. Goodeve remarks that

> doubtless this is not from any difference of barometric pressure, but because these situations generally combine so many unfavorable sanitary conditions, as the moist subsoil, the worst drainage, the least ventilation and air movement, the most impure air, and the most dense populations.

It is well to bear in mind, however, that high mountain levels have at times been visited by severe outbreaks. In India it has been known to attack places like Kussowlee (6,000 feet above sea-level), and Dhurmsala, Dajeeling,.Jackatalla, and Murree (6,000 to 7,000 feet high).

Impure Water.—That polluted water, even when not directly contaminated by specific bacilli, may predispose to the acquisition of cholera seems self-evident.

Positive confirmation of the fact is furnished by the observations of Budd, Acland, Parkes, Snow, Simon, Farr and many others.

From Simon's report of the last two London epidemics the following unequivocal demonstration of the point under discussion is found: The mortality among the consumers of water supplied by two companies presented enormous differences. The population subjected to this involuntary test amounted in round numbers to half a million. The two companies were

> The Lambeth Water Company, which drew its supply from the Thames at Ditton, above the influence of the London sewage and tidal flux; and the Southwark and Vauxhall Company, which drew its supply from the river near Vauxhall and Chelsea. The water of the Lambeth Company was tolerably pure; that of the Southwark and Vauxhall Company was very impure. The water of both companies was distributed in the same district at the same time and among the same class of people, the pipes of the two companies being laid pretty evenly in the same areas, in many places running side by side in the same streets, and the houses sup-

plied being pretty equally distributed. The deaths in the houses supplied by the Lambeth Company were at the rate of thirty-seven, and in the houses supplied by the Southwark and Vauxhall Company at the rate of 130 to every 10,000 persons living. It appears, therefore, that of the drinkers of the foul water, about three and a half times as many as those who drank the purer water died of cholera.

In the light of Koch's doctrine it may be questioned whether, among other impurities, an admixture of specific microbes had not occurred to make the Southwark water so fatal.

Impure Air.—Noxious effluvia arising from decaying animal or vegetable matter, refuse, excreta and the like may vitiate the air we breathe and make it prejudicial to health, thus indirectly inviting the spread of cholera. It is not always the most odorous emanations, however, that carry with them the greatest danger. Aitken justly says that districts in which "the most putrid odors tainted the air have sometimes almost entirely escaped, while others contiguous to them have suffered severely."

Still the delicate olfactory organs may detect atmospheric impurities, when other means fail to indicate their presence. In the city of New York offensive odors have repeatedly formed a just cause of complaint by private citizens, without, however, having led to an abatement of the various nuisances that spread their sickening stenches far and wide. Even if the nose is not the true index of danger, it is nevertheless well to remember with Goodeve that—

> In spite of exceptions, the places in which air is most vitiated from privies, cesspools, drains, decaying animal and vegetable refuse, or from overcrowding and concentration of human emanations, are those in which cholera has generally been most fatal and most widely spread.

Again, as long ago as 1832 an English writer, Mr. Orton,[1] pointed out that

> an atmosphere impregnated with the products of fermenting excrement is at once the most obvious and most constant concomitant of cholera (the privy or fecal contamination theory).
>
> Such exhalations were often found, even in a concentrated form, in houses where the existence of any palpable cause of insalubrity would scarcely be suspected, and thus the fact is in some measure explicable that the pestilence, sometimes passing over slums and rookeries, knocked at the door of the comfortable annuitant or the wealthy tradesman. It was found that persons appeared to suffer in proportion to the contamination of the air they breathed with the privy odor, and that immunity from this appeared to secure immunity from cholera.

That diarrhœal diseases are readily produced by the emanations from putrid refuse is well known, and as such diseases decidedly influence the predisposition to cholera, the importance of the subject becomes at once apparent. Indeed the history of cholera abounds in so numerous and such unequivocal illustrations of this general law, that it is not necessary to further dwell on the matter here.

Tainted and Adulterated Food.—In our age of fierce industrial and commercial competition, poisoning from adulterated foods is no uncommon occurrence. Where food has become tainted or when it has been purposely adulterated, the human organism will suffer in accordance with the quantity of the noxious substances ingested. It is readily supposable that this may be so insignificant as to result in no marked departure from health, and yet there may be enough gastro-intestinal irritation to create a predisposition on the part of individuals and groups of individuals to the acquisition of cholera.

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[1] London Medical Gazette, vol. x., 1832, p. 222.

In the light of Koch's doctrine we must regard with suspicion any cause that may disturb even slightly the normal functions of the alimentary canal. For it appears that, in addition to the introduction of specific bacilli into the body, there should be some departure from health sufficient to produce a favorable soil for their growth and multiplication. That tainted, decaying, or actually putrescent foods of all kinds are in themselves quite sufficient to induce choleraic symptoms is a fact long known to the profession. And many so-called localized outbreaks of cholera have depended for their origin upon some such cause.

Conclusions.—In spite of the extremely conflicting statements contained in the different theories regarding the nature of cholera, its communicability and the mode of its conveyance, the writer holds that the following points must be regarded as facts proved to be such by the weight of unimpeachable evidence.

Cholera originates in India, where alone it is now endemic. It is carried to this country, and indeed to all other countries, through no other agency than that of human intercourse. Its acquisition includes the possibility of direct individual contagion, but more particularly infection by choleraic fomites.

The specific cause of cholera is an organized body capable of rapid multiplication both within and without the human organism.

Certain animals may take cholera, and the disease is experimentally communicable to them.

While cholera does not originate *de novo* in a given locality, there are nevertheless certain general, local, and individual conditions that favor both its outbreak and its dissemination.

The choleraic virus acts first and with greatest intensity upon the intestinal portion of the alimentary canal.

Direct personal contagion, though not impossible, is a far less frequent mode of communication than indirect spreading by fomites. The intervening agency of specific organisms is necessary even for what we call direct contagion. Water channels, such as rivers, pipes and sewers are very frequent carriers and disseminators of the infecting cause. The air is only quite exceptionally a means of conveyance, and that only for short distances.

The truth of the above propositions cannot be gainsaid. In the opinion of the editor the probabilities are in favor of a further proposition, *i.e.*, Cholera is induced by the entrance into the intestines of peculiar minute organisms, first accurately described by Koch and since known as comma-bacilli. The writer has purposely refrained from placing this personal belief in the same category with the facts above stated.

From this brief *resumé* of the editor's views on the causation of Asiatic cholera, it appears that our etiological knowledge is not as complete and satisfactory as could be wished. But if this be construed as a reproach to medical science, it applies with the same force to the etiology of other infectious diseases. Now far from being discouraged by the insufficiency of what is positively known, we should endeavor to turn it to the best practical account. And meantime further inquiries should be pushed diligently forward, until we may finally be in possession of the full truth regarding the intimate nature of this and other pestilences.

PART THIRD.

THE SYMPTOMATOLOGY, COURSE, DURATION, MORTALITY, COMPLICATIONS AND SEQUELÆ OF CHOLERA.

BY

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OF NEW YORK.

CHAPTER XXVII.

CHOLERAIC DIARRHŒA AND CHOLERINE.

General Remarks.—An attack of Asiatic cholera being invariably the result of specific infection, it is but natural that the disease, like others belonging to the important class of infectious maladies, should give rise to symptoms differing widely in the degree of their severity. The special causative agent is the same in kind always. But it may find entrance into the system in large or small quantity, the result being, *cæteris paribus*, violent or mild manifestations. In addition, the usual modifying circumstances of acute disease, such as special predisposition or other imperfectly understood peculiarities, will of course influence to a great extent the gravity of the individual attack. Nevertheless the essential character of the clinical symptoms always remains the same. It is readily seen that in admitting the potent factor of personal predisposition, we must be prepared to allow that a small quantity of the causative agent may, in some cases, do as much mischief as a much larger quantity would create in certain others. For wherever the particular condition of the person infected favors a rapid multiplication of the virus within his body, it is clear that even an originally minute amount of the same may speedily assume very large proportions. But this does not in the least affect the general truth of the proposition made above concerning the usual relation between the quantity of specific poison introduced into the system and the severity of the symptoms that follow. For convenience of description, it is well to distinguish between three grades of infection from cholera, namely:—I. CHOLERAIC DIARRHŒA; II. CHOLERINE; III. PRONOUNCED CHOLERA.

Before entering upon a separate examination of these three forms, the editor would again emphasize the fact that they constitute merely clinical types of one and the same disease. The division is, therefore, strictly speaking, an arbitrary one—a circumstance that, when lost sight of, is apt to lead to confusion.

Now Asiatic cholera in its mildest form may occasion so slight a departure from ordinary health that its existence, in many cases, will hardly be suspected, and indeed clinically it easily escapes recognition. In view of recent discoveries it may, perhaps, be possible to positively diagnosticate even the mildest cases by a careful employment of bacterioscopic methods, the practical details of which are fully explained in another chapter. But the ordinary methods of clinical examination are inadequate to accomplish this object. It is hardly necessary to emphasize the importance of this subject; for the history of cholera abounds in unfortunate illustrations of the fact that even the mildest attack of this disease may lead to the production in others of decidedly grave forms of the affection.

In other words, fatal infection may be quite innocently—because unwittingly—spread by a person affected with painless choleraic diarrhœa. Contrast with this exceedingly mild manifestation of a specific infection the gravest types of fully-developed cholera, in which the poor sufferer is doomed, at the very outset, to a speedy death, and we may well stand appalled at a scourge that can assume the treacherous guise of such harmlessness, while its true nature seems ever ready to crop out in the shape of disastrous epidemics.

I. **Choleraic Diarrhœa.**—True choleraic diarrhœa—that is, diarrhœa dependent upon specific infection, is observed only during the prevalence of an epidemic. Scattered cases may of course occur before the nature of the affection has been recognized. But the epidemic character of cholera, after the disease has once been imported, cannot long remain hidden, except when desperate attempts at concealment or misinterpretation can be successfully carried out by the connivance of guilty authorities.

Choleraic diarrhœa, or cholera diarrhœa, has clinically no decidedly characteristic attributes. It occurs suddenly, as a rule, and the discharges are copious, and often quite thin and serous. They are generally a little bile-stained, and lose this attribute only when increasing frequency of purgation occurs. Ordinarily the passages do not exceed three or five in the twenty-four hours. Occasionally, however, their number is increased to ten or twelve. There is diminished appetite or complete anorexia. In addition, the patients commonly complain of thirst. Abdominal rumbling and gurgling noises are often present. But as a rule there is neither colic, griping, nor tenesmus.

A slightly bitter taste, perhaps some nausea, general malaise, headache, tinnitus aurium, and occasionally cramps in the calves of the legs, include about all the subjective signs of this form of the disease. We find also a more or less coated tongue. So, too, a tendency to coldness in the extremities may be manifested, but actual lowering of the body temperature is rare, and generally indicative of further mischief. Slight febrile movements and sweating have been observed. A little later a sense of profound exhaustion, out of all proportion to the objective signs, may be experienced.

This diarrhœa may last from two days to two weeks, and even when it does not eventuate in the graver forms of the disease, it frequently shows a tendency to relapse during the whole course of an epidemic, and this too in individuals neither previously nor subsequently subject to such a disorder. (Lebert).

The specific nature of the diarrhœa is undoubted, as shown by ample experience. Nevertheless judicious treatment is potent for good, and a large proportion of cases make rapid and complete recoveries. It is in the neglected cases that choleraic diarrhœa so frequently becomes the precursor of the graver and more fatal forms of the disease.

The importance, therefore, of this type of cholera for the individual lies in the fact that it is premonitory of danger, though not in itself particularly dangerous. And the importance for the community results from the infectiousness of the dejections, and the possibility of a single case becoming the center of infection for a large number.

From the preceding it appears that, clinically, simple and choleraic diarrhœa have so much in common that, as already stated, a differential diagnosis may be impossible in a given case. Nor are we helped over our difficulty by observing that babies, the very aged, and cachectic or weak persons in general, often succumb to this form of cholera from progressive exhaustion. For it is well known that protracted simple diarrhœa may result fatally in persons belonging to one of the classes just mentioned. But to repeat, if Koch's doctrine is true, then the detection by cultivation and otherwise of the cholera-bacillus would remove all doubt from a suspicious case.

II. **Cholerine.**—This form of Asiatic cholera differs but little clinically from ordinary cholera morbus. The arbitrary boundary line separating cholerine from choleraic diarrhœa is the occurrence of vomiting, in addition to the diarrhœa. The latter, however, need not always precede the vomiting. Indeed Griesinger states that simple diarrhœa is a precursor of cholerine only in a minority of cases—a statement which is certainly at variance with the observations of many competent writers. Cholerine begins abruptly, as a rule. Several days of languor, and vague uneasiness, often associated with loss of appetite, may precede it. Usually at night, or toward early morning, the patient is suddenly attacked by purging. At first the dejections are colored with bile, but they quickly lose their bilious character, soon becoming more purely serous, and already showing a resemblance to the characteristic rice-water stools of pronounced cholera.

The dejections of cholerine are more copious and occur with greater frequency than those of choleraic diarrhœa. Purging once established, vomiting does not, as a rule, tarry long. At first only the contents of the stomach are ejected, then bitter and sour, and still later tasteless, watery fluid comes up. Marked debility with a tendency to collapse may quickly supervene.

The patients complain of epigastric pain, and often suffer from a sense of abdominal pressure. Griping occurs, but it is by no means a constant symptom. Thirst may become distressingly intense. Vertigo and tinnitus, and even syncope are apt to occur. Painful sensations in the muscles of the legs, or actual cramps, frequently arise. The countenance soon becomes altered giving the first indication of the future "*facies cholerica.*" The tongue is now pappy or dry. The skin grows cool, the voice rather faint and husky. The secretion of urine is more or less diminished, and albumen may already be present. If serous depletion still continues, in consequence of the profuse gastro-intestinal transudation, the urinary secretion speedily becomes almost or quite suppressed.

Cholerine is dangerous in proportion as its symptoms remain intractable and indicate a seemingly irrepressible tendency to run into the last type, that of pronounced cholera. But, on the whole, it may be said that recovery from cholerine is the rule. Convalescence, however, is apt to be marked by relapses, following the least provocation, such as slight errors of diet, cold, fright, and the like. This shows clearly enough the weakened and irritable condition of the whole body, and more particularly of the alimentary canal.

Sometimes a mild typhoid condition supervenes to retard recovery. The patients remain very weak, develop a slight febrile movement, have a mild diarrhœa, with thirst, sweating, coated tongue, and occasional albuminuria. But even from this somewhat alarming condition complete recovery generally occurs.

CHAPTER XXVIII.

PRONOUNCED CHOLERA, INCLUDING THE PRODROMAL STAGE, THE PERIOD OF ATTACK, AND THE STAGE OF REACTION.

THE fully-developed disease may be conveniently considered under three separate headings, embracing—A. THE PRODROMAL STAGE; B. THE PERIOD OF ATTACK; and C. THE STAGE OF REACTION.

Before we proceed to examine the various phenomena of these three divisions, it should be stated that although such a grouping is by no means unnatural, yet the transition from one stage of the disease to the following one may occur by practically unappreciable gradations. Moreover, careful observation has shown that different epidemics exhibit considerable variations in respect to the manner of development and the duration of these different stages.

Lebert justly says that nearly every epidemic has a physiognomy peculiar to itself.

With regard to its behavior at different times he writes: "It often begins with the lighter forms and then passes into the graver, which may then prevail to the end, but it may also present a high mortality from the start. In some cases, it is rather the poor, in others all classes of the population, that are attacked. In many places it lasts a few weeks or months, in others a year and more. In medium-sized or larger cities, in which it has already prevailed, it is but little noticed by the majority of the inhabitants; while in others it snatches away one-fifth or one-fourth of the population, spreading universal terror and horror. In the same city we see some streets and public institutes more than decimated, while in the neighborhood the cheerfulness and frivolity, or the work of the inhabitants, are scarcely interrupted by the individual cases of disease and death. In the same epidemic there is such a complexity in the manifestations and course as can scarcely be exhibited in the most faithful description."

A. The Prodromal Stage.—This marks the invasion of the body by the infectious agent. Concerning the period of incubation, which is held by different writers to last from twelve hours to several days, we have no definite knowledge. Frequently in a typical attack of cholera, the patient first experiences an undefined malaise, his spirits are depressed, he feels physically more or less exhausted, disinclined to follow his ordinary occupation. He becomes vaguely anxious, irritable, perhaps even a little confused. Ringing in the ears, giddiness, headache, epigastric oppression, restlessness, inability to sleep, may be added to these discomforts.

Griesinger also mentions a tendency to cold hands and feet, sensations of formication in the limbs, marked irritability as regards the sense of hearing, and occasionally audible abdominal rumblings.

General and nervous manifestations of this kind, that probably already depend upon the action of the specific infecting matter, may be confounded with the consequences of fear, panic, or other physical disturbances; neurotic and hysterical phenomena may also result from attempted fasting, or other revolutionary changes in personal habits that the timid or ignorant are apt to undertake with the idea of escaping the dreaded disease. Generally all such maneuvers, by depreciating the general health of an individual, have the opposite effect of what was intended by their adoption. Thus over-cautious and nervous people of the upper classes, as well as the careless and illiterate of the lower classes, may artificially engender in their bodies a predisposition to acquire a disease that ordinary common-sense measures might aid them in effectually escaping.

Diarrhœa may still be absent at this early period of vague constitutional manifestations. In not a few cases, however, it precedes the symptoms just enumerated by a measurable interval.

The group of morbid phenomena described under the heading of choleraic diarrhœa often marks the beginning of grave cholera—a point which is of considerable importance in practice. There is no regularity about the order of appearance of these various symptoms, nor do they attain the same degree of prominence in different cases. In a word, there is considerable variety in the mode of onset of this disease—a circumstance that has been already alluded to as not devoid of significance, on account of the errors in diagnosis to which physicians are thus exposed.

Concerning this uncertainty, Stillé says:

> A curious feature of this disease is that sometimes the onset even of its graver forms is not attended by any evacuations, although the stomach and intestine may be filled with liquid. It is perhaps chiefly in such cases that the patient experiences a rapid depression of all the mental and physical faculties. The senses are irritable, the head aches and is confused, there is a disinclination to sleep, the limbs totter under the weight of the body, the pulse is frequent and feeble, occasionally fainting takes place; the skin is cool and bedewed with perspiration. In other cases, again, the attack is sudden; the patient is smitten with an unaccountable feebleness, speedily followed by profuse vomiting and purging and general spasms, and dies without any suspension of the symptoms or any tendency to reaction.

B. The Period of Attack.—It happens at times that the prodromal stage is so insignificant in the mildness of its symptoms as to be entirely overlooked. The patient is then at once plunged, as it were, into a sea of violent and distressing manifestations characterizing the period of attack. It has often received the name of algid, cyanotic, or asphyxial stage, when fully developed. But these terms, as also the designation "stage of collapse," and all similar terms, appear somewhat prejudical and one-sided. For they unduly emphasize a single phenomenon among several of equal conspicuousness, rather than that they serve to characterize the whole period of attack, and in this way this employment may prove misleading.

In some cases the attack itself follows in the wake of the more or less developed prodromal symptoms already described. In others it is ushered in precipitately without forerunners. Its beginning in the majority of cases is observed at night, or toward early morning.

Copious watery purging of a highly characteristic fluid always occurs. Where no diarrhœa has preceded the attack, the first few stools are very large, and carry away the entire intestinal contents usually mixed with bile. Hence these evacuations may still look dark and be of pappy consistency.

Very speedily, however, there begins a tempestuous discharge of fluid resembling rice-water or whey.

The peculiar appearance of these stools is very characteristic. They are thin, pale, watery, inodorous, and if there is an abundance of flocculi and larger flakes they may assume a somewhat opalescent or milky aspect. From their resemblance to water in which rice has been washed or boiled, they are by common consent spoken of as *the "rice-water stools"* of cholera.

Now these evacuations are never attended with *great* pain; in fact, often they are absolutely painless. Nor is there any visible effort on the part of the patient to void them, the thin fluid seeming to flow away from him as if poured from a tube or vessel. As a rule, there is considerable intestinal gurgling and frequent borborygmi may be heard.

The number of discharges is extremely variable. There may be only a few, but often they occur to the number of fifteen or twenty. A fair average is ten. But as many as 60 have been observed in the twenty-four hours.

In quantity the stools also show much variation. Ordinarily a passage amounts to four or six ounces, but the patient may lose as much as a pint or even a quart at a time. The latter, however, is quite rare.

Vomiting, if it has not previously occurred, is now added to the distressing symptoms. At first the contents of the stomach come up. Soon, however, the ejected matters assume the same peculiar rice-water or whey-like appearance which characterizes the fluid that escapes from the bowels. "This fluid is ejected with considerable force from the mouth, as if squirted out of a large syringe, and each effort of vomiting is followed by more or less exhaustion to the patient" (Macnamara). Some patients, on the other hand, vomit with apparent ease, as if there were a simple overflow from the mouth, or at most a regurgitation, following slight effort. In some cases there occurs, at times, a gush of fluid simultaneously from mouth and bowels. Along with these "tempestuous discharges" there are now observed grave manifestations of other kinds.

Thirst, already intense, soon becomes excessive, but all attempts to quench it are futile, for drinks when swallowed are almost immediately rejected.

The secretion of urine, which before was more or less diminished, is now suppressed. The tongue looks flabby, pale and thinly coated. It is protruded with difficulty, and there may be much trembling. General debility rapidly increasing to utter prostration appears. Dizziness, tinnitus, palpitations, a sense of oppression and fear, as already stated, usually precede the period of extreme exhaustion, but in some rapidly fatal cases, they are not pronounced.

Excruciating *cramps* in various muscles, but especially in the calves of the legs, almost invariably set in. A distressing hiccough often torments the sufferer. The voice grows feeble, and on effort only a husky, harsh, high tone is produced (*Vox cholerica*).

The patient's general appearance likewise undergoes a marked alteration during this period. The eyes sink back in their sockets, and assume a vacant, staring look. Dark wide areolæ appear around the lids. The features shrink, the nose becomes sharp, the lips thin and pallid the cheeks and temples hollow. A dusky hue, verging on cyanosis, spreads over the skin, which also grows cold and clammy, especially over the distal parts of the body. A little later it becomes shriveled as if sodden, and wrinkles spontaneously appear at the finger tips. If at this time a fold is pinched up, the loss of cutaneous elasticity prevents its quick subsidence. And now, too, the temperature falls. It sinks rapidly several degrees, the thermometer registering 94° or 95° F. in the axilla.

At the same time the pulse grows small and weak. It may become thready, or for a time disappear altogether from the wrist. In point of frequency it varies from 90 to 120 beats per minute.

The breathing is short, shallow and hurried. There may be over forty respirations to the minute, but generally the number is 25 or 30.

The duration of these symptoms is uncertain. They may last less than one hour, endure a few hours, or persist a whole day. A gradual abatement of their severity may mark the turning of the tide in favor of ultimate recovery. Unfortunately this happens in the smaller number of cases. In the majority the attack continues and all existing signs are still intensified. The condition that follows is often separately described as characterizing the algid or collapse stage, or the period of asphyxia. But, as previously stated, it properly belongs to the period of attack, as the symptoms merely denote an uninterrupted progression of the disease from bad to worse. Still, the fact is not to be lost sight of that death may happen before and recovery take place after well-marked collapse.

To resume our narrative then, the purging and vomiting still continue, but with diminished violence. The stools may become slimy, frothy, or gelatinous, or they may continue to have a rice-water appearance.

Thirst remains intense, and the patient, if started out of his apathy through the violence of the cramps, or when roused by attendants, is still eager for drinks—drinks that unfortunately never satisfy. Exhaustion is yet more profound, and the patient sinks into a semi-comatose condition. But unconsciousness is not developed, and he generally answers questions intelligently, though only very languidly and in a husky whisper. When not disturbed he lies on his back motionless, cold, inert, the ghastly picture of a living corpse.

Emaciation rapidly advances; the surface of the body has a leaden pallor or looks livid; the lips, nose, ears, fingers and toe-tips are pinched, cyanotic, shriveled. The wrinkles of hands and feet are often very marked.

There is now an icy coldness about the body, and even the breath is cool. The integument is moist with a cold clammy sweat. The temperature may be down to 80° F. The heart sounds become feebler and feebler. Soon they are scarcely audible. The pulse has entirely faded away. Even in the carotids or the femorals there may be no perceptible beating. An artery cut at this time no longer bleeds. From a punctured vein dark thick blood will ooze slowly, but it does not turn crimson on reaching the air. At length circulation seems to have come to a complete standstill; the second sound is no longer heard; even the cardiac impulse may cease to be felt. The voice, shortly before still audible as a husky whisper, is now quite extinct. The countenance has grown intensely anxious, or it is frightfully distorted. Hollowness of temples and cheeks is more conspicuous than ever. The eyes have fallen back into their orbits even more deeply than before, the encircling areola is yet darker, deeper, and wider. The half-open lids reveal a dry, lack-luster cornea and bloodshot conjunctivæ. About the nostrils and lips dry blackish sordes collect. Here and there the icy surface is still moist with viscid perspiration. The urine remains completely suppressed. Without movement, cold and blue, the patient lies in dull lethargy, or death-like stupor. And indeed the rapid and labored, though shallow respirations may be the only indication that life still flickers in the body, which by this time may be so wasted and shrunken that all identity of person is obscured or obliterated. Nevertheless even at this supreme crisis small stools may yet be unconsciously voided into the bedclothes; but most of the transuded fluid accumulates in the bowels. At length the senses become quickly clouded, vision fails, breathing is slower and jerky, cyanosis spreads and deepens, the eyes are convulsively dragged upward, coma becomes complete, a faint moaning may perhaps be heard, and death at length mercifully terminates the distressing scene.

The imperfect description just given cannot portray the death-struggles that choleraics sometimes pass through. But it does not appear necessary to dwell further on the symptomatology of these last moments. One important point, however, must still be noticed, namely, that when anxious relatives, experienced attendants, and even wary physicians, have given up all hope of recovery; when the exhausted patient, or rather his wasted body, lies in bed motionless, pulseless, blue, and icy cold, when death seems already to have claimed another victim, even then the almost incredible may happen, and a sudden favorable turn launch the poor sufferer forth upon the stage of reaction, culminating perhaps in uninterrupted recovery.

Thus it appears that the same misleading uncertainty marking the earlier periods of an attack of cholera, may likewise be observed at the very end. And it is this possibility of rapid change, a treacherous oscillation between hope and despair, that at times makes the disease so painfully perplexing to all concerned in its management.

C. The Stage of Reaction.—Quick as was the sequence of events that seemed to conspire in hurrying the patient to his grave, just as rapid may be the turn-about to integral restoration. Yet such a sudden change is seen in only exceptional instances. As a rule, the restorative processes appear gradually and continue to mature, as it were, rather slowly. Relapses, complications, various sequelæ, are so many stumbling blocks in the way of smooth, uninterrupted recovery.

Concerning relapses, it is unnecessary to say anything further than that during the entire stage of reaction, even when the patient seems already quite out of danger, the confident promise of his recovery may be turned to utter hopelessness by a speedy return of former symptoms. Once more the fickleness of the disease, as we feel tempted to call this characteristic of cholera, appears in all its delusive uncertainty. Writers have attempted to explain away this possibility of relapse, by calling it imperfect or insufficient reaction. But such pseudo explanations solve no problems and leave matters where they were before. As regards complications and sequelae, they will have to claim our separate attention further on.

Simple reaction, in favorable cases, is marked by a return of warmth to the body, at first slight and evanescent, then more pronounced, and finally permanent. The heart sounds become again audible, and a little later pulsation is also perceptible at the wrist. The discharges are less profuse, or entirely checked. When they do occur, at longer and longer intervals, they lose their rice-water appearance, and gradually become feculent and pappy.

With the return of pulsation and warmth, the cyanosis also fades away. The kidneys slowly resume their function, though the urine is still albuminous. Cramps no longer torment the patients, whose facial expression improves visibly. Respiration becomes free, deep, and easy. The voice regains its tone. For a time thirst remains rather troublesome. Soon there is some return of appetite. A natural calm, followed by grateful sleep, may occur, and complete convalescence is established in a period varying from a few days to several weeks.

A goodly number of cases do not show this steady progress toward recovery. Circulation may seem unembarrassed, yet warmth does not return to all regions of the body. The distal parts remain cool, and even the heat of the trunk may again be lost. The pulse too shows inconstancy, wavering between strength with regularity and weakness added to disturbed rhythm. Anuria persists or follows the first free flow of urine. Diarrhœa may remain, vomiting recur, and troublesome hiccough again supervene. The countenance is neither calm nor natural, the cheeks remaining hollow, and the eyes sunken. Great restlessness or a tendency to somnolence is witnessed. Respiration, too, remains embarrassed; and while a favorable turn may at any moment happen, the patients more frequently pass into a peculiar typhoid condition, in which various secondary processes and complications arise that often end in death. The various phenomena that may follow a typical attack of cholera will be considered further on.

In a small proportion of cases reaction may be properly spoken of as being excessive. The return of warmth is rapid, and well-marked. The face grows red, the conjunctiva is congested, and the eyes incessantly water. Cardiac action becomes violent, the pulses bound, a throbbing headache, somnolence, and perhaps slight delirium, accompany the development of a decided though moderately intense febrile movement. A return of different functions marked by profuse perspiration, the passing of a large quantity of urine, or even the appearance of menstruation may arrest the further development of these symptoms to the typhoid condition already mentioned. Excessive reaction depends in all likelihood upon various congestive conditions of internal organs which, when not soon relieved, assume the more serious aspect of structural changes. A consideration of the latter belongs more properly to another chapter.

CHAPTER XXVIII.

ANALYSIS OF THE LEADING SYMPTOMS OF ASIATIC CHOLERA.

HAVING given an account of the course of events after infection with cholera, sufficient, it is believed, to illustrate the clinical history of the disease, we are now prepared to examine a little more closely some of its leading symptoms. In so doing it appears advisable to take up in orderly succession the phenomena belonging to the different systems or organs affected by cholera.

The Organs of Digestion.—The alimentary canal, being most prominently concerned as regards the manifestation of morbid phenomena belonging to cholera, will first claim our attention. If there is any primary localization of the disease, it takes place always in the intestinal tract.

Diarrhœa is the chief, the most constant, and the most characteristic symptom of an attack of cholera. It is generally also the first positive indication of existing disease.

Even in those rarer cases of extremely rapid development, called *fulminant* by the Germans, and *foudroyant* in France, some diarrhœa either precedes vomiting and the other graver signs, or it occurs simultaneously with them. The appearance of diarrhœa as an initial symptom finds ample illustration in the recorded experience of many accurate observers. Thus in 1849 Devillers reports that it was present 420 times, in 538 fatal cases. Briquet saw it 145 times in 188 patients; Mesnet in 1865, 140 times in 213 cases; Horteloup, 40 in 100; Langrone, 49 in 106; Stoufflet, 343 in 534 (Laveran).

In regard to the occurrence of ordinary cholera-diarrhœa and cholerine, it has been found that different epidemics show considerable variations. Lebert, who has given special attention to this matter, says:

> I am inclined to believe that cases of prodromic cholera diarrhœa are more frequent and more widely diffused in malignant and extensive epidemics than in those of less extent. In the great Paris epidemic of 1849, which numbered about ten thousand victims, the prodromic diarrhœa was absent in from five to ten per cent. of the pronounced cases of cholera, while I observed it to be absent in Zurich, in 1835, in one-third of the pronounced cases; and yet no conclusion could be drawn from this circumstance as to the course of the disease. On the whole, prodromic diarrhœa was absent in just as many cases of those who subsequently recovered as in those who succumbed to the disease. I found that, during the prevalence of cholera, the prodromic diarrhœa was absent in seven-eighths of the cases of true cholerine (with colored stools). In Paris, as well as in Zurich and Breslau, in 1866 and 1867, I saw a number of cases of diarrhœa which were due to the influence of cholera recover without treatment, and without subsequent cholera. On the other hand, I observed, in July and the beginning of August, 1866, such obstinate and violent cases of cholera diarrhœa in the Breslau

garrison of cuirassiers, where I had charge of a large ward of wounded patients, that it required heavy and quickly repeated doses of opium to prevent an outbreak of cholera. There is no marked distinction, it is true, between common intestinal catarrh and cholera diarrhœa, yet the latter has many peculiarities. Its inception is mostly sudden and unexpected, often excited by colds or errors in diet. Loss of appetite, thirst, indigestion, are either absent or present in only slight degree; patients feel extraordinarily feeble and uncomfortable, considering that the diarrhœa is neither frequent nor copious. There is nothing specially peculiar, however, in the character of the fluid stools. Often there are but from one to three in the twenty-four hours, during the day or night, more rarely from six to eight or more; rumblings and gurglings are very distressing to most patients. In some cases the diarrhœa lasts only one or a few days; in others, with interruptions, from one to two weeks. In some individuals who have not previously suffered with intestinal catarrh, the diarrhœa returns frequently during the whole course of the epidemic, and then ceases entirely after it. Even in the milder cases of cholera diarrhœa we sometimes observe individual signs of cholera of temporary duration, as suppression of urine, light cramps in the calves, colorless, rice-water stools, which occur, however, more frequently in cholerine. It is not a rare occurrence, either, for a cholera diarrhœa, which remains in other respects without danger, to suddenly increase in virulence, with violent, quickly repeated stools, as in true cholera, and yet cease quickly and be followed by recovery.

The copious stools of true cholera come on suddenly, and are repeated at short intervals, the time varying between ten minutes and two hours. They may be accompanied or followed by a little pain about the umbilicus. There is no tenesmus. In bad cases alvine incontinence comes on early; in moderately severe cases not at all. Sometimes the copious transudation is retained within the intestines. At others the blood speedily becomes so thick that further transudation is impossible. These are very grave cases. Before the first appearance of the rice-water stools, there often occur a few more or less colored evacuations. Greenish, yellow, brownish, even blackish and quite exceptionally sanguinolent discharges have been observed. The rice-water stools may look like limpid water; more frequently, however, the presence of grayish shreds and flocculi results in some turbidity of appearance.

In quantity the evacuations rarely exceed one pint at a time. Still, even at this rate, it is readily seen that six or seven quarts may be voided in 24 hours. The flakes and flocculi are composed of leucocytes, detached epithelium, and mucous corpuscles. They form a distinct sediment when rice-water discharges are allowed to stand. Granular débris from the disintegration of epithelial cells is also present in great abundance. The reaction of fresh rice-water stools is always alkaline. Generally they are quite inodorous. When allowed to stand, the flocculent portions, as already stated, sink to the bottom of the vessel, leaving a supernatant limpid, whitish or gray fluid.

Macnamara states that "this separation of the material into two parts takes place rapidily in many instances, say in from one to three hours, and is evidence of the severity of the disease; for if the more solid matter of the dejecta collects in the lower part of the fluid very speedily, it indicates the complete death and disintegration of the organic matter. On the other hand, if the separation of the fluid and more solid components takes place slowly, it is on account of the evacuation containing a considerable quantity of comparatively healthy mucus, and the case, so far, allows of a more favorable prognosis." In spite of this authoritative statement, we are not of opinion that any reliance should be placed on the prognostic value of this simple test.

Microscopically examined, the flocculi, as already stated, are found to [illegible] more or less disintegration. [illegible] bacteria are present in more [illegible] and various other organisms [illegible] observers to constitute [illegible] Koch inaugurated the era [illegible] suddenly emerged from [illegible] territory of exact research. [illegible] from the historical standpoint. [illegible] Thomé, Nedswetzky, Pacini [illegible] here.[1] Nevertheless this [illegible] organisms have conclusively [illegible] be invested with powers of [illegible] the credit of having found a [illegible] significance, in all probability [illegible]

[illegible] to consist mainly of a dilute [illegible] sodium chloride, ammonium [illegible] salts are either not at all [illegible] proportion of solid matters [illegible] Albumen and other organic com- [illegible] quantities.

[illegible] discharges at different periods of the [illegible] the results of his analyses:

ANALYSES OF THE EVACUATIONS IN CHOLERA.

[illegible]	[illegible]	Albumen in 1000 Parts	Extractive in 1000 Parts.	Sol. Salts in 1000 Parts.	Total Solid in 1000 Pts
[illegible]	[illegible]12.9	0.466	3.846	9.04	13.9
[illegible]		0.29	6.82	5.99	13.1
[illegible]	[illegible]9.0	2.4	1.27	10.98	14.65
[illegible]	[illegible]9.5	1.18	0.55	9.14	10.87
[illegible]		2.18		7.52	9.7
[illegible]	[illegible]8.3	.027	2.23	8.33	10.83
[illegible]	[illegible]5.8	3.2		5.827	8.947
[illegible]	[illegible]4.0	20.84		6.34	27.8
[illegible]	[illegible]8.91	1.48	6.055	9.085	16.62
[illegible]	[illegible]7.83	0.855	17.355		18.21
[illegible]		*	4.589	3.881	8.47

* Not weighable.

On the other hand Papillon[2] obtained the following results from two analyses:

	I.	II.
Water,	98.12	97.15
Amorphous matter,	0.14	0.08
Alkaline chlorides,	0.69	0.85
Alkaline lactates,	0.12	0.15
Alkaline sulphates,	0.96	0.94
Phosphates,	0.05	0.03
Loss,	0.02	0.80
	100.00	100.00

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[1] All the more important observations germane to this subject will be found in Part II of this volume.

[2] Journal d'Anatomie et de Physiologie, Paris, 1865.

If the stools are tinged with blood and begin to have a disagreeable or even fetid odor the prognosis is much more unfavorable, than when they continue to be merely watery or whey-like.

The exact pathological significance, or rather the precise pathogeny of this copious and tumultuous flux remains undecided, in spite of all that has been said and written upon the subject. Probably it is in a great measure due to the local irritation of the specific infective agent of cholera, whether this reside solely in the microbes or is conveyed by other means to the mucous coat of the intestines. But that vaso-motor disturbances are largely concerned in its production cannot be questioned, in spite of the opposing views of eminent writers.

In view of the latest parasitic doctrine concerning cholera, it is decidedly interesting to remember what, years ago, was written by Lebert on the origin of the symptom under discussion. As the result of an extended experience, this careful observer says: "The anatomical changes, the hyperæmia of the mucous membrane, the distention of the mesenteric veins with thick blood, the ecchymoses and hemorrhagic suffusion of the mucous membrane, the swelling and very great softening of the lymphatic apparatus of the small intestine, are, I am convinced, not the cause of the rice-water stools, but are, with the stools, the effects of a vast development of cholera germs, which intensely irritate the lymphatic portion of the small intestine and excite a rapid hypersecretion, like poisoning by arsenic and other metallic salts, and like the action of the very severe drastic purgatives. The view defended by Griesinger, that the rapid and active transudation from the intestinal mucous membrane and the different catarrhal and dysenteric affections may be excited through the condition of the blood itself, has, it is true, much in its favor; the infection of the fœtus with cholera through the mother, for instance, lends it support. But when this author entirely rejects the local action of cholera germs, he goes, in this respect, I believe, too far."

And again, touching the view which assumes that cholera is merely an intense hydrorrhagia with consequent thickening of the blood, he writes that it is "as much strained as the older neuro-pathological, electrical, and other hypotheses." In summing up, the same author says: "Much obscurity still hovers, however, over the effects of cholera on the whole organism—an obscurity which can only be cleared up by accurate clinical, histological and chemical analyses. According to our present histological knowledge, beside the thickening of the blood, we find the different tissues and organs undergoing degenerative processes, which not only produce grave disturbances, but also introduce into the organism from the degenerated tissues injurious products of metamorphosis. Nothing is more instructive in this regard, perhaps, than the tolerably constant participation of the kidneys in the cholera process, and the manifold effects resulting therefrom."

It has been previously pointed out that at times the watery transudation is not discharged from the bowels. This is quite probably due to a paralytic condition of the intestines. Cases showing this peculiarity are generally grave, and when death occurs the intestines are found to be filled with the characteristic fluid. Formerly it was customary to speak of *cholera sicca*, whenever such a condition was seen. More recently, however, the term has been given up, as apt to convey the erroneous notion of a special and separate variety of choleraic disturbance.

The varying quality and quantity of the fluid stools of cholera are not without practical importance as regards prognosis. The most favorable condition is when they occur with moderate frequency and continue to show traces of coloring matter, in spite of their otherwise watery appearance. Very large stools are of course unfavorable on account of the severe drain on the system implied by excessive transudation. In the same way it is not a good sign to witness a more or less abrupt cessation of discharges, while the other signs of the disease continue or even grow worse. Decidedly bloody stools are always ominous. Early in the disease they mean intense hyperæmic irritation of the mucous membrane. Later they denote various degenerative processes with necrosis, ulceration and the like. In almost all cases the small intestines are the source of whatever bloody admixture is observed in the stools.

Vomiting is a less constant symptom than diarrhœa, although in the great majority of cases it soon follows the first discharges. Even when vomiting fails to take place, the occurrence of nausea shows that the stomach is at all events affected by the disease-process. That stomachic digestion is early impaired or abolished is further shown by those rare cases where very late vomiting still brings up remnants of undigested food, and again by autopsies in which masses of ingesta are found almost unchanged in the alimentary canal.

In point of frequency the attacks of vomiting vary considerably, occurring from ten to twenty-four times in as many hours, or coming on only a few times throughout the entire course of the disease. Indeed, as previously stated, some very grave attacks end in death without vomiting having occurred at all.

Initial vomiting rids the stomach of its contents. At first there may be painful gagging, and visible exhaustion follows the act. Later, however, with increasing frequency of vomiting the fluids are ejected without apparent effort.

They seem to well up from below by involuntary painless regurgitation and issue at the mouth in a steady stream. Less frequently they are thrust out convulsively in interrupted jets. The quantity of the vomitus depends, *cæteris paribus*, upon the quantity of fluid which is taken to satisfy the patient's constant thirst. But even when little fluid is allowed, the copious regurgitation clearly indicates that gastric as well as intestinal hydrorrhagia may take place in cholera. This is further shown by the investigations of Schmidt,[1] who found urea and ammonia carbonate in the vomited matters of cholera patients. The character of the ejected fluid, as previously pointed out, depends at first upon the nature of the stomach contents. Soon, however, it assumes a distinctly watery appearance. In the limpid liquid, flocculi float in greater or less abundance. In a word the vomitus now resembles completely the rice-water discharge from the bowels. Blood is an occasional slight admixture, but profuse gastric hemorrhage is unknown. Winge and v. Hönigsberg have reported the occurrence in rare instances of chocolate-colored discharges, simultaneously from above and below.

Among 1,600 cases observed by Drasche, he failed to observe such a phenomenon in a single instance.

The specific gravity of watery vomit may be as low as 1005, rarely it is higher than 1010. Its reaction, as a rule, is sour, although some observers report to have found it neutral or even alkaline.

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[1] Charakteristik der epidemischen Cholera gegenüber verwandten Transudationsanomalieen. Eine physiologisch-chemische Untersuchung von Carl Schmidt. Leipzig, 1850.

The proportion of sodium chloride is much less than in the alvine discharges. The presence of albumen is affirmed by Lindsay and Heller. Schmidt, on the other hand, was unable to detect it. Bile pigments in small quantities are an almost constant admixture.

The sediment which the watery vomitus deposits shows squamous epithelial cells (rarely cylindrical epithelium), mucous corpuscles, granular débris, and often fat droplets. Lindsay reports finding sarcinæ, the result of fermentation. Such an occurrence must be quite rare, since the cholera attack is usually of so tempestuous a character that time for fermentation is not provided. The finding of vibrios is likewise infrequent and, as a rule, denotes that decomposition has occurred in the fluid outside of the body.

A point of considerable importance, especially as regards medicinal treatment, is the condition of the gastro-intestinal surfaces in relation to its powers of absorption. Now it is certain that the assimilative capacity is always much reduced. Nevertheless in some cases it does not seem to be completely abolished. Hübbenet,[1] Duchaussoy,[2] Wagner,[3] and others have shown that large doses of strychnia, belladonna and other powerful drugs were inert when introduced into the stomach during the attack, whereas injected into the blood, their physiological effects were still obtained. But in 1855 Drasche instituted a series of observations with readily diffusible substances such as iodide of potassium. And as the result of his positive experience he claims that some absorption must take place, even during the period of attack.

Griesinger has also pointed out that ingested substances are by no means always recognizable as such in the discharges, having undergone alterations as regards their color and smell.

On the whole it seems that the importance of this matter justly entitles it to further accurate study, with the aid of modern methods of experimental investigation. But this much we know, namely that during the height of an attack, the function of the gastro-intestinal mucosa is so completely reversed that it becomes a transuding in place of an absorptive membrane.

The appearance of the *tongue* changes with the development of the different stages of an attack. Being less an index of the state of the digestive organs than a result of the patient's general condition, which is better judged from other symptoms, it follows that no great weight attaches to lingual appearances. Participating in the changes of other distal organs, we find it growing cold and blue, or even blackish as the attack advances. Flat, flabby, moist and coated with a moderately thick layer of grayish material, in the earlier stages, it becomes cleaner, and apparently smaller later on. When a typhoid condition develops, it grows dry, and parched, its color changing to red or brown, and crusts appearing on its surface.

While the *appetite* may remain unchanged in the prodromal period, complete anorexia characterizes the fully developed attack. When questioned, patients complain of a bad taste in the mouth, but voluntary statements regarding its presence are rarely made.

It is quite different with regard to *thirst*. This is one of the most constant and troublesome symptoms, as well as one of the earliest and most persistent. The poor sufferers crave cold drinks to satisfy their sense of internal heat. Fluids are eagerly swallowed only to be immediately rejected. Vomiting again intensifies thirst, and a pitiful *circulus vitiosus* may thus be inaugurated. Even during the period of convalescence thirst may long remain as a troublesome accompaniment of gradual restoration. Of course the immense drain of water through the copious intestinal flux is accountable for the intense thirst of cholera patients. In profuse hemorrhages, it is well known that excessive thirst forms a characteristic phenomenon.

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[1] Bericht über die Cholera, etc. Berlin, 1848.

[2] Gazette des hôpitaux, 1854.

[3] Schmidt's Jahrbücher, vol. 88, p. 249.

The Abdomen.—At the commencement of an attack many patients complain of griping or colicky pains. The abdomen may be quite tender to the touch and more or less firmly retracted. Later on the muscles relax and a flabby, doughy condition develops. Palpitation then readily reveals the presence of gurgling fluids. Succussion sounds may be loud and distinct. When the patient suddenly shifts his position, such noises may be plainly heard at some distance from the bed.

Singultus may occur at any time during the course of the disease, but it is most frequently observed in collapse, when it may replace vomiting. Though very troublesome it is an unimportant sign, and denotes merely the participation of the diaphragm in the violent muscular contractions that accompany the disease.

Very soon after the onset of profuse watery discharges, decided changes are witnessed in connection with

The Organs of Circulation.—Among the early effects of cholera infection we often notice violent palpitation, accompanied by anxiety, fear, and a vague sense of distress. This soon gives way to more positive signs of disturbed circulation. With advancing transudation the heart's action grows feeble, the apex beat is diminished or scarcely perceptible, the systolic sounds may be replaced by a faint blowing murmur, and at length the second sound is no longer heard.

Pericardial friction sounds have been described, and accounted for on the supposition of dryness of the sac. This may appear plausible at first sight, but the fact that such sounds occur so rarely strongly militates against this view. Pericardial dryness is without doubt a constant accompaniment of the excessive intestinal transudation of cholera. But when friction sounds are plainly heard, they denote pericarditis in cholera as well as in any other disease.

The area of cardiac dullness has been repeatedly found diminished, and the inference drawn therefrom that the right side of the heart becomes distended only quite late in the course of an attack. Indeed Macnamara, in his most recent publication on cholera,[1] asserts the accumulation of blood in the right side of the heart to be a post-mortem occurrence. In spite of this statement it appears to be more in accordance with analogous events in other diseases to interpret this phenomenon as due to an antemortem acute dilatation, resulting from increased demands upon the working force of a much-weakened dilatable organ. On the other hand it will not be disputed that dilatation occurs rather late in the course of an attack of cholera. In this connection it may also be stated that Johnson does not believe in a cessation of circulation from cardiac debility, as seen for example, in exhaustion. According to him the right side of the heart becomes filled with blood, and circulation generally is impeded in consequence of a direct mechanical obstruction of the onward course of the blood. The further view, long advocated by him, that the collapse of cholera as well as the other symptoms of that condition are due to obstructed pulmonary circulation from arterial spasm excited by the virus of disease, he entertains to this day. For at the recent debate on cholera before the Royal Medical and Chirurgical Society,[1] the presiding officer being no other than Dr. Johnson, he took pains once more to present an array of facts borrowed from experimental physiology and a series of arguments of a more theoretical nature, all of which, he held, distinctly supported his well-known doctrine.

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[1] Article "Cholera," in Quain's Dictionary.

The pulse. As a rule, *pari passu* with the diminution of cardiac action, progressive changes are noticed in the character of the pulse. At first there is increased frequency, amounting to 100 or 120 beats per minute; later on the pulse may run down to 90 or even 80; still later it generally rises again to 140. Simultaneously with its primary acceleration, the pulse grows small, feeble, and soft. After a while radial pulsation is replaced by a mere flickering undulation. At length even this ceases, although death still lingers for minutes or hours, and even the possibility of recovery remains.

In pronounced collapse, pulsation is no longer felt in the larger vessels such as the carotids, brachials, and femorals. At times, however, the pulse though exceedingly feeble may be felt to the very end. And this may occur even in cases running a rapid course. On the other hand in a certain proportion of "*foudroyant*" cases, it disappears early, never to return.

A remarkable fact in this connection deserves mention here, namely that peripheral pulsation may be quite imperceptible while the heart still throbs so violently as to cause the patient to complain of præcordial pain and oppression.

The thickening of the blood and arterial spasm (Johnson) may explain this phenomenon. Besnier[2] and Lorrain[3] have found that sphygmographic tracings taken during collapse show an almost horizontal line with occasional faint elevations corresponding to the diastole. Lorrain also states that dicrotism when present is more marked at night than during the day.

In slow reaction the pulse remains small, perhaps filiform, readily compressible and quite frequent. In quick reaction it is much less compressible and often decidedly bounding. In the so-called typhoid reaction, the pulse may be ample, but it remains compressible, and often shows marked dicrotism. It has little stability, and slight causes produce decided acceleration, that quickly subsides when the exciting cause ceases to be operative.

Searle[4] on opening arteries during the attack saw the blackish blood exude slowly. Dieffenbach[5] and Magendin[6] found the exposed arteries thin, narrow, lax, in places almost collapsed. When cut into, some vessels were found empty. Once in the case of a moribund patient, Dieffenbach introduced a catheter from a slit in the axillary artery almost into the heart.

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[1] London Lancet, March 28, 1885.

[2] Besnier, Recherches sur la nosographie et le traitment du cholera. These de Paris, 1867. [3] Études de médecine clinique, etc. Paris, 1868.

[4] Cholera: Its Nature, Cause and Treatment, etc. London, 1866.

[5] Observations physiologiques et chirurgicales faites sur les cholériques. Berlin, 1835.

[6] Leçons sur le choléra morbus, etc. Paris, 1832.

But no blood flowed from the instrument, nor after withdrawal was any found in its interior. Little clots have also been seen in the arterial lumen, while life was not yet extinct. In sharp contrast with this arterial emptiness we find venous stagnation occurring during the progress of the attack. The never-absent lividity or cyanosis is in part explained in this way. Extreme cyanosis is favored by the darkness of the blood and previous plethora. In anæmic cholorotic, or cachectic persons this bluish or purplish hue is replaced by a more leaden lividity.

In consequence of venous stagnation, as above mentioned, the external veins, especially those near the heart, sometimes rise considerably above the level of the skin. The *vis a tergo* may be so reduced that no blood, or only very little, issues from an opened vein, although the vessel may be found fully distended with it.

Owing to the rapid serous depletion the previous plumpness of the body quickly disappears. The tissues, in place of being bathed in healthy serous fluid, are called upon to give up their own juices. Emaciation is therefore speedily developed, and may progress to an extreme degree; as Marey has tersely expressed it, choleraics even during life-time become cadavers (*les cholériques le cadavérisent*).

According to Graefe,[1] except during the agony of death, retinal circulation continues; but in no other pathological condition is the volume of retinal blood found so much reduced.

The profound blood-stagnation witnessed in cholera is brought about by a combination of causes. It is in large measure due to the great thickening and increasing viscidity of the fluid. Griesinger has pointed out that the reduced temperature, especially pronounced in the distal parts of the body, is also a factor to be taken into account in this connection.

Another potent cause of this stasis is the great reduction of cardiac power. And there can be no doubt that in many cases death in the period of collapse is the immediate consequence of heart-failure. The nutrition of the central organ of circulation must quickly suffer along with that of the body at large. An added cause of cardiac weakness may be found in disturbed innervation, so often seen where sudden abdominal disease-processes are lit up, and besides all these causes the specific action of ptomaines or other poisons belonging to cholera doubtless greatly influences the entire vaso-motor apparatus. It is in this way that we may admit the factor of vascular spasm so strongly insisted upon by Johnson and his followers.

The *blood* is necessarily changed both quantitatively and in its composition, by the enormous intestinal hydrorrhagia. A primary alteration due to specific infection has been often assumed but never positively demonstrated.

As regards the diminution in volume, it is of course proportionate to the amount of transudation. In some very severe cases Monneret[2] was unable to collect from the body more than eight or ten ounces.

The specific gravity of choleraic blood-serum has been estimated variously as 1036 (Herrmann), 1044 (Wittstock), and 1057 (Thomson). Healthy blood-serum, according to Garrod, has a specific gravtiy of 1028.

Various microscopical alterations have been from time to time described as occurring in the corpuscles. But it does not seem that observers have been able to discover any constant and characteristic change. We will, therefore, not examine the theoretical statements advanced by different writers to account for such changes, as they claim to have found.[1]

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[1] Archiv für Ophthalmologie, vol. xii.

[2] Compendium de médecine pratique. By Monneret and Delaberge, Paris.

We may mention here, however, that an increase in the proportion of leucocytes to colored corpuscles is tolerably certain; but its pathological significance is in every event a mediocre one.

The thickening of the blood, as already indicated by the figures showing increased specific gravity, is further shown by the tarry or syruppy condition of the fluid as it flows from the living body, or as it is found in the cadaver. Coagulation is imperfect, and no serum, or only very little, is separated from the clot. Shaken up in contact with air, the dark color is transformed into a reddish tint. Schmidt found that the maximum thickness of the blood was reached about 36 hours after the first marked symptoms of an attack. During the period of reaction the blood quickly imbibes the previously lost water—a circumstance that may possibly account for the persistence of thirst.

The large proportion of urea present in choleraic blood also deserves to be mentioned. It was noticed by O'Shaugnessy[2] as early as 1832. Marchand,[3] Scharlau, Garrod,[4] Schmidt, Heller and others confirmed it by subsequent examinations. O'Shaugnessy found as much as one grain of urea in an ounce of blood, which is much more than ordinarily occurs in Bright's disease. The enormous loss of water of course results also in an increased proportion of the other solid constituents of the blood. Thus we find more salt, more phosphates, and more potassium compounds than normal.

The Respiratory Apparatus.—The term cholera asphyxia, as Asiatic cholera has been frequently called, sufficiently indicates that circulatory and respiratory disturbances may come so prominently to the front as to push other symptoms relatively into the background.

In the milder forms belonging to the asphyxial type, if type it deserves to be called, there is seen the phenomenon know as "air-hunger," associated with which there is a sense of heavy oppression. In more violent cases there is intense respiratory agony, with interrupted, exaggerated, accelerated breathing. All the remaining force of the patient seems thrown into the one great effort to catch his breath. But extreme cholera dyspnœa of this kind is only rarely seen. On the other hand, it not infrequently happens that a patient passes through an entire attack of cholera without visible changes in the mechanism of his respiration. From beginning to end breathing remains natural. And even in fatal cases, patients may be for hours in pulseless collapse without any apparent interference with normal respiration.

In most instances, however, the thickening of the blood quickly following upon the copious serous transudation, marks the beginning of altered breathing, which, as just stated, may result in violent dyspnœa. The fact that, even in such extreme cases, auscultation reveals no local change adequate to explain the dyspnœa, taken in conjunction with the further circumstance that post-mortem examinations give negative pulmonary evidence, naturally makes us look elsewhere than in the lungs for an explanation of cholera-dyspnœa. And indeed it is not a strained assumption which makes the altered condition of the blood and the weakened heart responsible for the difficult breathing. The blood is thick and viscid, it stagnates in the veins and capillaries, and although there is not enough of it to lead to œdema or marked congestion, yet the heart is unable to propel it. Oxidation is necessarily imperfect. Cyanosis of the surface thus indicates what may be termed pulmonary cyanosis. In other words there is a decided preponderance of venous over arterial blood.

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[1] The most recent investigations concerning the blood alterations of cholera will be found under Morbid Anatomy.

[2] Report on the Chemical Pathology of the Malignant Cholera; containing analyses of the blood, dejections, etc. London, 1832.

[3] Ueber das Vorkommen des Harntoffs, etc., in Erdmann's Journal für praktische Chemie, vol. xi., p. 458, 1837.

[4] On the Pathological Condition of the Blood in Cholera. London Journal of Medicine, 1849.

We conclude, therefore, that the dyspnœa of cholera is preëminently a cardiac and hæmatic one, and that pulmonary disturbances play a secondary rôle in its production.

Attempts have been made to measure the diminution of respiration by an examination of the expired air. Although scientific accuracy can hardly be claimed for these investigations, the conclusion is nevertheless warranted that a noticeable diminution of carbonic acid exists in the expired air of cholera patients.

Clauny and Baruel even went so far as to assert that in the graver cases the air was returned from the lungs unchanged. Davy found a reduction of two-thirds in the amount of carbonic acid exhaled. Rayer also discovered a marked lessening in the amount of oxygen absorbed. (Laveran).

Doyère[1] made as many as 70 analyses of air, and found the reduction proportionate to the gravity of the case. He concluded from his examinations that the quantity of oxygen consumed and carbonic acid produced became progressively less until the end. And further, that a return to more normal respiratory conditions marked the advent of reaction.

The asphyxia of cholera differs, therefore, from ordinary suffocation in that the pulmonary condition is one of anæmia rather than congestion, and further in the fact that in cholera, cardiac disturbances precede for a long period the pulmonary disorder.

Again the dyspnœa of cholera at times becomes a veritable orthopnœa. Drasche believes that a tonic spasm of the diaphragm may account for this symptom, which is generally associated with precordial pain and great anxiety on the part of the patient. The respiratory rhythm may be changed in such a manner that one deep inspiration is followed by a number of short expiratory efforts.

It has been already pointed out that the expired breath of cholera patients often feels quite cool. The number of respirations varies within wide limits. There may be only eight per minute; and again the number may exceed 45.

Romberg has called special attention to the marked diminution of sensibility on the part of the respiratory mucous membrane. Accumulated secretions, or irritant vapors, excite no reflex cough. The tracheal rattle is not heard in death from cholera.

At the height of the attack, visible respiratory movements of the chest may be absent. Auscultation still elicits a faint inspiratory murmur, but expiration is noiseless.

Drasche frequently heard pleural friction sounds, but other observers say little or nothing, about their occurrence.

In the period of reaction, bronchitis and various pulmonary inflammations are observed, in some epidemics forming the rule, in others constituting only exceptions.

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[1] Comptes Rendus, 1849, and Mémoire sur la Respiration, etc., Paris, 1868.

A frequent but by no means constant respiratory disturbance, known as the *vox cholerica*, consists in a marked alteration of the voice. At first there may be only slight hoarseness. This is followed by more decided huskiness, then comes a mere whispering voice, and finally complete aphonia. The change in the patient's voice is not necessarily in correspondence with his general condition. Drasche states that he found patients at the acme of a rapidly developed attack able to talk plainly. On the other hand the first appearance of loose bowels may be immediately followed by a changed voice. Indeed in some "*foudroyant*" cases complete aphonia appears simultaneously with the initial discharges. Yet there can be no doubt that the voice may improve without any amelioration of the patient's general condition.

Dryness of the larynx and vocal chords, or an atonic condition of the laryngeal muscles have generally been invoked to explain this singular phenomenon. It has been pointed out by Drasche, however, that disturbed innervation is apt to be the chief factor in the production of the vox cholerica, and in the light of modern research this is the proper explanation of the peculiar phenomenon in question.

The Temperature.—As soon as the transudation of fluid into the intestines leads to disturbed circulation, the peripheral parts of the body begin to grow cooler. From the hands, the feet, the ears and nose, the coolness gradually extends over other parts of the body, until at length the entire surface may have an almost icy feel. In marked contrast with this objective coldness, which has been often borrowed to designate one period of the attack as the algid stage, we find the subjective sensation of heat that so many patients complain of.

It is a noteworthy fact, however, that although the thermometer indicates a decided falling off in the bodily heat, nevertheless this is by no means commensurate with the sensation of coldness communicated to the palpating hand of a healthy person. Griesinger accounts for this apparent discrepancy on the ground of a reduction in the loss of surface heat by irradiation from the skin, as evidenced by the slow rise of the thermometer. And he further believes that the clammy feel of the moist skin conveys an exaggerated idea of actual coldness.

This certainly is a very plausible view of the matter, and may be accepted as sufficiently explanatory of the phenomenon. The slow rise of the thermometer may also explain the difference in the figures given by several authors. It is important, therefore, whenever accuracy is desired to allow the instrument to remain in position at least twenty minutes.

The rapid vacillation of the temperature of the body is a peculiarity belonging in a greater degree to cholera than to most other diseases. Thus it may happen that a difference of several degrees, up and down, occurs within an hour. Warmth is likewise very unevenly distributed throughout the body, one part being quite cold, whereas another still feels decidedly warm.

Whenever the coldness of the body is at all pronounced and uniformly distributed, its degree affords a sign of the gravity of the case. Indeed, in very mild attacks the body-heat may remain normal throughout.

The observations of Casper, Czermak, Magendie, Burgières, Monneret, even Briquet and Mignot, v. Bärensprung and other earlier writers are untrustworthy as regards registrations of the bodily temperature.

But the later reports of Zimmermann, [illegible], Lorain, have furnished us with more reliable figures. From these it appears that the temperature varies considerably according to the part of the body in which it is taken. The difference between axillary and rectal warmth may be ten or twelve degrees in the collapse stage.

[illegible] gives the following table showing comparative average temperatures:

Axilla	92.7° F.
Under the tongue	90.5°
Upon the tongue	81.5°
In the nose	79.2°
On the palm of the hand	84.0°

The temperature of the mouth is generally too low to be utilized as an index of the general heat of the body. The same applies to the nostrils and tongue. There can be no doubt that evaporation of moisture from these parts brings about some lowering of temperature. It has been maintained by a few writers that the coldness of the expired air was an additional factor at work in this direction. But this is quite improbable.

During reaction normal or slightly elevated temperatures are observed. Rapid falling off in the temperature at this period is a grave prognostic sign; and rapid elevation of temperature, except when reaction begins, is also an unfavorable symptom.

In the typhoid state a regular rhythm is not discoverable, the temperature being still subject to sudden fluctuations, from causes that escape detection. Just as we find a post-mortem elevation of several degrees, so there may occur a decided ante-mortem rise. The latter is found, however, only within the body. From accurate records of 74 patients, Lorain[1] tabulates the following figures:

Deep rectal temperature.

MINIMUM.		MAXIMUM.	
93.2° F.	in 1 case.	104.0° F.	in 5 cases
95.	" 2 cases.	102.2	" 15 "
96.8	" 10 "	100.4	" 27 "
98.6	" 28 "	98.6	" 2 "
100.4	" 11 "		

The axilla, but more especially the extremities, show much greater oscillations. Magendie reports cases where the hands and feet showed a temperature of only 64.5°–70° F. Lorain records the following:

Temperatures in the mouth.—77° F., 1 case; 80.6°, 1 case; 82.4°, 2 cases; 84.2° 4 cases; 86°, 6 cases; 87.8° 5 cases; 89.6°, 7 cases; 91.4°, 5 cases; 93.2°, 6 cases; 95.0°, 4 cases; 96.8°, 6 cases; 98.6°, 3 cases.

In healthy reaction blood and warmth return simultaneously to the peripheral parts, and the previous internal elevation sinks back to the normal standard.

If reaction is interfered with, owing to the presence of complications, the blood may return to the distal parts, while their temperature still remains lower than it should be. But this does not militate against the assertion that diminished peripheral circulation is largely responsible for the low temperatures of distal parts in the period of attack.

The Integument. The changes occurring in the color of the skin constitute a prominent symptom of cholera. The distal parts are first seen to lose their natural hue, and invariably the discoloration is more marked there than over the trunk. Pallor generally precedes the lividity and extreme cyanosis of an advancing attack. The reduction in temperature just described is accompanied *pari passu* with deepening cyanosis. In the absence of the latter the parts, as a rule, are observed to retain their warmth.

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[1] Études de médecine clinique, Paris, 1868.

Between the frequency and copiousness of the discharges and the cutaneous discoloration a similar correspondence does not appear to exist. For in some cases a few large discharges will find the patient cyanotic to the last degree, whereas in others, repeated evacuations are followed by only slowly increasing blueness.

In rapidly developed deep cyanosis, intense oppression, dyspnœa, abolition of reflexes, and a semi-comatose condition are not infrequently seen. Indeed it was for a long time customary to speak of a paralytic, asphyctic, or cyanotic stage.

Beginning cyanosis is first seen about the eyes, the finger-nails and toes. In thin patients the turgescence of superficial vessels often becomes well-marked. Hæmorrhagic extravasations into the skin, but more particularly into the conjunctiva, have been observed as a consequence of this repletion.

On account of unequally distributed lividity or cyanosis the skin often assumes a marbled appearance. Drasche frequently saw cutis anserina principally over the chest, abdomen and arms. A great variety of hues may be seen in different cases, owing to the differences in healthy complexions. Cyanosis is not always present in cholera. In fact Levy has described a separate class of cases under the heading of white cholera, on account of the persistent absence of this symptom.

Cholera cyanosis differs essentially from the similar discoloration of other diseases in being associated with more or less marked cutaneous changes that have no resemblance to ordinary conditions; whereas the skin in the usual diseases accompanied by cyanosis is if anything thickened, swelled, or œdematous, the very opposite is seen in cholera. For in this disease the integument quickly shrinks and shrivels, losing its turgescence and elasticity. It becomes wrinkled at the finger-tips and in other distal parts. A fold pinched up does not readily subside. The eyelid may be pulled in any direction without resuming its natural position, except very slowly. A parchment-like cutaneous hardness may develop. But often, instead of being quite dry and hard, the breaking out of a clammy sweat leads to persistent moistness. Nevertheless perspiration is rarely observed all over the body. The forehead, neck, and hands may be found bedewed with viscid sweat, that collects in large drops, while the trunk has a dry, leathery feel. Cold sweat is always a graver symptom than warm perspiration, but a favorable prognosis is not justified merely on the strength of a change from one to the other.

It has been noticed that patients would sink into collapse after the appearance of copious sweating, as if the withdrawal of even this small amount of fluid had produced a deleterious effect. More probably, however, deeper causes are here at work, and the sweat, though seemingly a primary, is in fact a secondary manifestation.

The touch of a moist choleraic skin may very aptly be compared to that of amphibious animals.

Cholera sweat has an alkaline reaction in collapse. Later on it again becomes sour.

Cutaneous sensibility may suffer to such an extent that sinapisms, blisters and other irritants produce no visible effect.

Drasche states that when blistering does occur the patient experiences no pain therefrom. Cauterization singes but does not, according to Griesinger, lead to blistering of the skin.

When cut into, the skin looks bloodless, the severed edges do not gape, and the general appearance is that seen in the cadaver.

That cutaneous and subcutaneous absorption is rarely completely abolished has been shown by many experimental trials. That it is always more or less impaired is equally certain.

The loss of cutaneous elasticity, coupled with the shrinking and atrophy of the underlying soft parts, results in such changes of facial expression that patients are scarcely recognizable. Perhaps the most conspicuous alteration is witnessed in connection with the eyes. The lids are not moved over the entire surface of the bulb. The latter falls back into the bony orbit, and even the cornea may become somewhat wrinkled on account of loss of intraocular fluid. Often it is seen to be dry, speckled with accumulating dust, and later it is quite opaque. Seitz has seen the cornea undergo rapid softening, becoming converted into a pappy substance. Mummification of the sclerotic, especially in its lower segment, is often observable. Extravasations into the conjunctiva, the choroid and sclerotic have been frequently noticed.

The general atrophy and rapid emaciation seen in cholera belongs in like degree to no other disease. The face especially, as already stated, shows a marked wasting that results in an expression of countenance not easily forgotten when once seen. The chief characteristics of this *facies cholerica* having been previously described, need not be here repeated.

In advanced cases the extremities appear to consist solely of bone and wrinkled skin.

When pathological accumulation of fluid distends the skin or fills the cavities of the body, a speedy absorption is inaugurated with the onset of cholera. Barlow has narrated the case of a man suffering from dropsy, who passed large quantities of watery fluid, and though he became livid and clammy, made a good recovery. But "when he began to recover from cholera his appearance was almost ludicrous, from the manner in which the integment hung loosely about him." Similar instances have been also described by other writers.

The Urinary Organs.—The kidneys secrete only sparingly shortly after the first onset of the disease, the urine having a high degree of concentration. Soon only a few drops at a time are passed, and a little later entire suppression supervenes. But in some cases the last-named symptom is absent. Patients have stated that urine flowed from them along with the rice-water discharges, and their statements have been verified by competent observers.

But the complete suppression of urine in other cases is equally certain. Now the structural alteration of the kidneys at the early period when suppression first occurs, is quite inadequate to explain this remarkable manifestation.

In acute and chronic nephritis the actual histological damage is much greater, and yet some urine is often secreted until the very last. But in cholera the early appearance of albumen makes it quite probable that circulatory disturbances cause the symptom in question. Recent renal experimentation has clearly shown that diminished arterial tension may lead to albuminuria. Venous stasis may have and does have a like effect. Both factors are present in cholera, and it is reasonable to suppose that albuminuria and suppression of urine precede the more deep-seated pathological changes that choleraic kidneys undoubtedly undergo.

It is very creditable to Griesinger, and L. Meyer to have pointed out the possibility of explaining the symptoms under discussion in this mechanical way, long before positive experimental evidence was obtained or obtainable.[1]

Cholera patients often complain of a desire to micturate without the ability to pass water. Under those circumstances it may be found expedient to introduce a catheter. Generally, however, little or no urine will flow from it. Nor is it always an easy matter to introduce the catheter, on account of the violent urethral spasm provoked by attempts to pass the instrument into the bladder. Anuria may persist for hours and days. In some cases it has been observed to last over a week. The reappearance of urine witnessed in reaction may once more give way to suppression, as the patient passes into a typhoid state.

Anuria should not be confounded with absence of desire for micturition. The catheter will decide the question as to which condition prevails.

In 13 cases carefully watched by Lorain, urinary secretion was resumed between the second and eighth days of the disease. The following table indicates the

Amount of Urine passed and the Day of Resumption.

CASES.	DAY.	AMOUNT IN LITRES FOR 24 HOURS.
1	3	1.0
2	6	1.6
3	2	0.5
4	3	3.0
5	7	4.0
6	2	0.8
7	3	1.0
8	8	2.6
9	6	1.0
10	3	3.0
11	6	3.0
12	4	0.7
13	3	1.3

The urine of the early stage of an attack of cholera is rich in salts, it deposits urates, and, as already said, may contain albumen. The first urine, after suppression has existed for one or several days, has a muddy yellow or brown color. Its specific gravity very rarely exceeds 1010, and is often as low as 1006. It is more or less albuminous. In exceptional instances albumen may be missed. Urea and sodium chloride are found in considerably reduced proportions. Occasionally the latter is entirely wanting.

In addition such urine may deposit crystals of uric acid, casts, various epithelia, leucocytes, red blood-corpuscles, and oxalate of lime. Sugar, bile-pigments, hippuric acid and indican may be discovered, but only in small quantities. Parkes believes that vesical and renal (?) catarrhs invariably accompany or follow an attack of cholera.

The *Albuminuria of Cholera* has been studied by many observers. Hermann, Simon and other earlier writers did not fail to mention it.

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[1] Compare also the researches of Straus, detailed under Morbid Anatomy.

In 1849 its importance was pointed out by Levy, Gendrin, Rostan, and Martin-Solon. In Germany, Heller, von Oettinger, Oppolzer and Vogel drew early attention to it. Since then it has occupied the attention more particularly of Legroux, Gubler, Jaccoud, Lorain, Buhl, Virchow, Güterbock, Lebert, Drasche, Klebs, Thomson, Parkes, Griesinger and Laveran.

The milder form of temporary albuminuria, chiefly caused by disturbances of circulation, may be followed by more permanent and graver affections, involving structural changes of the kidneys. Nevertheless even the latter have scarcely ever been known to lead to chronic Bright's disease. Of course it should not be forgotten that the very cases where such an event might have occurred belong to that category in which recovery is an exceptional matter. It follows from what has here been described that the condition of the urinary organs may furnish important evidence with regard to prognosis. An early resumption of secretion, with progressive diminution of albumen and steady increase of the amount of urine voided, is a very favorable sign.

On the other hand, much albumen and the recurrence of complete suppression are to be regarded as ominous symptoms.

Glycosuria has been repeatedly observed, but it seems to be a merely temporary phenomenon belonging to the stage of reaction. Parkes found sugar in moderate amounts on the first and second days of reaction. Gubler[1] claims to have discovered glycosuria in very many instances. He also believes this sign to be quite characteristic of those cases in which cholera is more slowly developed than ordinarily. On the whole, however, the inference is warranted that glycosuria has no special significance, either as a prognostic sign or otherwise.

Polyuria, which generally comes on after or about the fourth day of reaction, has a physiological rather than pathological or clinical interest. Still it marks the reëstablishment of absorptive, assimilative and secretory power, and is most frequently seen in cases of complete and rapid reaction.

That the polyuria is not merely the result of drinking much water appears from the fact that the solids are excreted in larger amount than might be supposed. Thus Buhl ascertained that, while the quantity of urea passed with the concentrated urine of the first 24 hours of reaction rarely rose above one drachm, the amount excreted during polyuria might rise above two ounces. A corresponding augmentation was found in the amounts of the other solid constitutents. Güterbock and Lorain report similar observations.

The General Secretions.—Apart from the urine, the other excretions and secretions of the body show more or less constant changes both as regards quantity and quality.

The secretion of cold, viscid *sweat* has already been mentioned. Chemical examination has elicited the fact that it contains urea.

Doyére and Poirson state that they discovered grape-sugar in the perspiration of cholera patients during the period of attack. Burguières claims that the reaction is alkaline throughout the attack, and that the acidity is only restored with beginning reaction.

The *buccal* and *salivary secretions* are diminished to a much greater extent than the cutaneous secretions. The tongue and mouth may become quite dry in consequence. A pappy coating is sometimes seen on the mucous surfaces of the oral cavity.

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[1] Sur la glycosurie sympt. dans la période réact. du choléra. Gaz. des hôpitaux, 1866.

Frua says that choleraic saliva contains a large proportion of chloride of ammonium. And he is inclined to regard this as characteristic of cholera. At times it may have a sour reaction; as a rule it remains alkaline.

Bile continues to be found, though in reduced amount, throughout the whole attack.

The *lachrymal secretion* suffers considerably. It may become entirely suppressed. The changes resulting therefrom to the cornea and conjunctiva have already been described.

A coating of viscid material forming a thin film or a deeper layer of mucoid appearance, is seen in some instances.

The normal exudation moisture upon serous membranes, the formation of cerebro-spinal fluid, the generation of parenchymatous juices are all seriously impaired.

As regards the formation of *milk* in pue]peral women, while not abolished it is quickly reduced to a minimum. Drasche found the milk thick, of marked alkaline reaction, with an almost complete absence of chlorides and casein, and a diminution of sugar, albumen and other ingredients.

The Organs of Generation.—Uterine bleeding and utero-vaginal hemorrhages are often seen during an attack of cholera. A remarkable feature of their occurrence is found in the fact that they may arise after the menopause.

If a menstruating woman is attacked, the flow may be abruptly checked, but it usually reappears with the advancing disease. The hemorrhage is sometimes quite profuse, thus adding one more potent factor to the many causes of exhaustion and collapse already present. In the later stages of cholera, metritis with diphtheritic ulceration is no unusual event, and justifies a bad prognosis. The ovaries become the seat of hemorrhage (which generally takes place into the Grafian follicles) in a certain proportion of cases.

Concerning the male organs, nothing requiring special notice is known to occur. The urethra is dry and may be the seat of smarting sensations.

The Nervous System.—During an attack of cholera, marked symptoms occur in connection with the central nervous system. But it is noteworthy that the primary impression of choleraic infection is much milder than in cases of enteric fever. The remarkable views of Chapman, attributing the entire disease to primary nervous impressions, are noticed elsewhere.

The early neurotic manifestations of an attack of cholera are of a purely functional character. It is quite late in the course of the malady that actual structural alterations begin to appear. In fact even in the typhoid stage, meningitis and encephalitis are exceptional occurrences.

The repletion of cranial blood-vessels, œdema, the accumulation of urea in the substance of the brain, and similar processes, no doubt are responsible in some degree for what is seen during the life-time of the patient. Nevertheless the entire subject is still involved in uncertainty, and there is room for more accurate investigation. The rôle played by ptomaines and their poisonous effects upon the nerve centers also require further elucidation.

In the beginning of an attack the patient frequently complains of general malaise. Tinnitus aurium, vertigo, a vague sense of anxiety may then come on, especially with the appearance of the first evacuations. Then weakness, a changed expression of countenance, and great restlessness follow.

Intelligence may remain clear, but there is marked apathy amounting to utter indifference to all things in the graver cases. In the milder ones the patients may indeed seem apathetic, but they are nevertheless acutely attentive to their own condition as well as to everything that is going on about them.

Slight somnolence, torpor, some confusion of ideas, hardness of hearing, much diminished cutaneous sensibility, amblyopia, then deepening somnolence, followed by coma, are among the most frequent effects of cholera upon the nervous system. If somnolency makes way for renewed intelligent activity, a favorable turn in all other respects is the rule, and recovery is soon ushered in.

Cholera patients generally complain but little. Griesinger remarks that the first impression a cholera-ward makes upon the visitor is one of surprise at the reigning quietude.

There are cases, however, and they always belong to the class of graver ones, where patients are loud in their complaints and lamentations. They feel dizzy, are oppressed, there is præcordial pain, they constantly crave cold drinks and suffer from internal heat, they shift their position in bed to the best of their reduced ability, they cry and weep, sometimes screaming or moaning from the torture of incessant cramps.

In ordinary attacks of cholera, active delirium is not seen. Drunkards and very aged persons may mumble and mutter in low delirium. In violent reaction and in the typhoid stage, moderate delirium, or stupor, headache and sleeplessness are more or less common.

As a general rule all spinal reflexes are abolished in cholera collapse. Sprinkled with cold water such patients make no response; tickling of the throat is not followed by gagging or vomiting; irritant vapors provoke no cough. The sphincters no longer act. What urine is secreted accumulates in the bladder, injections are returned from the bowels, vomiting ceases, the voice has died away.

In this connection there may be mentioned the observations of Dr. A. Josias,[1] who during the recent outbreak in Paris had occasion to observe about 30 cases of typical cholera. From a clinical study of these cases he concludes that the tendon reflexes are more or less exaggerated at the beginning and during the activity of an attack. In convalescence and after recovery, on the other hand, they are normal or even diminished. In graver cases of rapid development exaggerated tendon reflexes appear to occur constantly. When the disease is developed more slowly this is a frequent but not constant phenomenon. In mild cases the reflexes remain normal.

The occurrence of *muscular cramps*, which has given the disease the title of spasmodic cholera, remains to be considered. In true cholera more or less violent spasms of single muscles and whole groups of muscles are rarely absent. It is singular to observe, however, how variable the extent and intensity of this symptom may be in different epidemics.

The character of the contractions is always that of tonic spasm, and the pain occasioned thereby differs greatly in different individuals.

Speaking broadly, it is certain that robust and previously healthy persons suffer more than the weakly or decrepit. This fact was already noticed in India many years ago, where Searle found the stronger Europeans much more frequently attacked by spasms than the more or less degenerate natives. Searle's observations have been confirmed by Macnamara and other later writers. Macnamara says in this connection: "Among the weak and poverty-stricken people of Lower Bengal, the contractility of their muscular fibers is at so low a standard that they frequently escape the cramps from which their more lusty up-country brethren, or Europeans, suffer so fearfully."

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[1] Du réflexe tendineux dans le choléra. Le Progrès Médical, December 31, 1884.

Although almost all the muscles of the body, including even some of the involuntary ones, may be affected, it is commonly only the extremities that develop marked cramps. Moreover the flexors appear to be oftener attacked than the extensors. Usually after the first few copious evacuations, and when the pulse is beginning to fail, these cramps make their appearance. The calves suffer first; then the fingers and toes become bent and rigid; next the chest, neck and abdomen, and at length the back is implicated. Visible lumps of great hardness may mark the position of the larger superficial muscles. The facial muscles and those of the jaw escape in the vast majority of cases. Yet Bouillaud saw a dislocation of the inferior maxilla in consequence of choleraic spasm. The exciting cause of the tonic spasms of choleraics is obscure. The absence of other signs of spinal disturbance, the negative post-mortem evidence, and the further circumstance that the symptom is not a constant one, militate against the view which attributes their appearance to a direct toxic irritation of the spinal cord by the cholera poison. Frey and others assert that the spasms originate in reflex irritaton starting in the gastro-intestinal mucous membrane. This explanation receives some support from the well-known fact that convulsions may be due to such causes, especially in children.

It has also been claimed that the imperfect and unhealthy blood-supply of the nerve-centers produces these contractions.

Griesinger, Potain and others believe that local muscular anæmia is accountable for the distressing phenomenon, and adduce much evidence in support of this view. What little blood is received by the muscles is physically and chemically so much altered as to furnish irritation rather than nourishment for these organs.

In summing up the debatable question under consideration, Stillé remarks that "probably all of these factors are associated causes in producing the spasmodic phenomena of cholera. It is well worthy of notice however, that spasms, which are so frequent in all infantile diseases, and especially in those affecting the stomach and bowels, rarely attack children suffering from cholera. This would seem to prove that the spasms in question are not reflex, but either central and spinal or else muscular —an inference which is strengthened by their being tonic and not clonic."

It does not seem probable or even possible that all these causes are operative at the same time in the same case. An inference which seems warranted by the evidence now at our command is that different causes may be at work in different cases. In the opinion of the writer, Griesinger's explanation is a more plausible one than any of the others. The altered muscular metabolism is clearly shown by the loss of water described by Middeldorpff, the increased proportion of urea pointed out by Buhl, and the excess in creatine noticed by Hoppe. The convulsions at times observed in the typhoid state are uræmic, and not characteristic of cholera.

CHAPTER XXIX.

THE COURSE, DURATION AND MORTALITY OF CHOLERA.

THE course of cholera has been amply illustrated in the foregoing, so that it seems scarcely necessary to again consider it here. But it will be interesting and instructive to examine some statistical evidence, more particularly as regards the mortality of the disease. This will further elucidate the course and duration of the disease, and thus justify the title placed at the head of the chapter.

As has been previously pointed out, the death-rate from cholera is a very variable one. Not only do different epidemics show variations that are found equally extreme in no other disease, but the same epidemic has a mortality-rate that is constantly changing. One fact, however, has been universally observed, namely, that the early history of an epidemic is associated with the largest number of victims, and that there is a tendency to gradual mitigation even while the disease may continue to spread. The wide territorial extent of an epidemic is not necessarily coupled with a high degree of mortality. If anything, the death-rate diminishes, so that places reached late may suffer but little, as if the virulence of the infecting agent had become exhausted in traveling long distances. For this reason we should have less dread of the disease in our own country than may be reasonably felt abroad. And if the partially exhausted poison reaching our shores is not called back to renewed life and malignant potency by finding favorable conditions for further development in the accumulated dirt and refuse of large cities, then we may forever hope to escape the horrors and panic of a largely fatal epidemic. The recent Parisian outbreak (1884) affords a good illustration of the peculiarity just mentioned. Cholera after ravaging Southern France, Italy, and Spain, at length appeared in the French capital. But being already rather exhausted with its long travels, and meeting with little encouragement in the way of dirt, water-contamination and other unhygienic conditions, it was quickly suppressed.

Some early epidemics are reported to have killed only 5 per cent. of those attacked. This seems highly improbable. On the other hand, several more recent outbreaks are positively known to have had a death-rate varying between 70 and 90 per cent. A broad average shows a mortality not far either way from 50 per cent.

The death-rate is evidently influenced in some measure by the geographical situation of a place, increasing as we approach the equator, and diminishing in proportion as we recede from it.

Local causes have a marked bearing on the death-rate. The quality of the soil on which houses are built, the drainage, the hygienic conditions surrounding the patients, are all influential in causing a high or low mortality.

There appears to be no constant difference in the death rate of general hospitals as compared with private residences. It should be remembered that the "general hospital" cases are recruited from the poorer classes of society, and further that on admission the disease has already made more or less headway. There is no doubt that, general hospitals show a higher death-rate than cholera hospitals. When the disease spreads from a cholera ward to the general wards a high mortality is inevitable. Thus in the epidemic of 1854 Haller found in the Vienna General Hospital a death-rate from cholera of 52 per cent. in the cholera wards, whereas the mortality from the same disease in the general wards rose to 74 per cent., and the same experience was had in the great epidemic of the following year.

Leubuscher reports a death-rate of 52.5 per cent. in the cholera hospital of Berlin, at a time (1850) when the general city mortality was 60 per cent. A well-managed cholera hospital is, therefore, calculated to save lives that would ordinarily be sacrificed.

We have just seen that the average run of hospital cases is apt to be more severe than in private practice. But there are compensating circumstances that should not be lost sight of. It is evident that immediate medical interference may in some cases at least, avert the impending fatal issue. Now even with the most intelligent assistance of trained nurses, the general practitioner is clearly placed at a disadvantage, when compared with his hospital confrere, who is ever ready to obey on the instant, the urgent summons of his patients.

In studying the records of mortality statistics, the fact must not be lost sight of that they will vary in accordance with the prevalent medical belief of a country. If during an epidemic the majority of physicians report all cases of diarrhœa as belonging to the category of Asiatic cholera, there will naturally be very many recoveries, and a corresponding decrease in the death-rate results therefrom. If, on the other hand, only the fully pronounced cases are allowed to be cholera, the opposite will take place; *i.e.*, there will seem to be a very high death-rate.

Drasche has made the practical suggestion that the appearance of rice-water dejections be taken as an index of the presence of true cholera. While this may not be pathologically correct, it will nevertheless insure uniformity of reports, and thus enable us to prepare trustworthy statistics,

The valuable monograph of the above writer contains a series of instructive tables that afford a better illustration of the various factors influencing mortality than lengthy descriptions can hope to convey. Several of these tables are here reproduced:

Mortality at Mannheim in 1849. (Frey).

AGE.	GENERAL.		MALES.		FEMALES.	
	Per cent.		Per cent.		Per cent.	
	Recovered.	Died.	Recovered.	Died.	Recovered.	Died.
1 to 10 years....	43.1	56.9	51.8	48.2	36.4	63.6
10 " 20 " ...	58.	42.	59.	41.	56.3	43.7
20 " 30 "	67.5	32.5	60.	40.	70.9	29.1
30 " 40 "	54.6	45.4	51.	49.	57.7	42.3
40 " 50 "	48.	52.	6.3	43.7	39.6	60.4
50 " 60 "	36.5	63.5	36.3	64.7	37.5	62.5
60 " 70 "	43.2	56.8	40.	60.	45.2	54.8
70 years and over	24.5	75.5	35.	65.	26.	84.

Mortality at Copenhagen in 1853 (Hübertz).

Age.	
0–3	71.3 per cent.
3–15	52.1 “ “
15–30	45.4 “ “
30–50	62.1 “ “
50–60	76.2 “ “
Over 60	86.0 “ “

It is unnecessary to make any comment upon the significance of these figures.

If we turn now to London and examine the official returns of the epidemic of 1854, we will have to read the same lesson:

Mortality at London in 1854. (Official Returns.)

Age.	
15–25	34.9 per cent.
25–35	35.4 “ “
35–45	43.4 “ “
45–55	50.1 “ “
55–65	58.2 “ “
65–75	71.4 “ “
75–85	78.3 “ “

The following table will be found instructive, being based on 1,630 personal observations with careful records made by Drasche in Vienna in the years of 1854 and 1855:

Mortality at the Vienna General Hospital in 1854 *and* 1855.

	Males.				Females.			
Age.	Died.	Re-cov'd.	Percentage of Deaths.	Percentage of Recoveries.	Died.	Re-cov'd.	Percentage of Deaths.	Percentage of Recoveries.
1–10	18	9	69	31	10	4	71	29
11–20	67	145	32	68	56	64	47	53
21–30	81	109	43	57	152	175	47	53
31–40	61	62	50	50	90	66	58	42
41–50	48	42	53	47	50	33	60	40
51–60	66	18	79	21	64	12	84	16
61–89	42	5	89	11	28	3	90	10

The following tables will be found of still greater interest, as presenting an accurate statement of the mortality from cholera and various factors influencing the same, in the United States, during the epidemic of 1873. They are taken from Dr. McClellan's report.[1]

It is clearly seen from a study of these tables, and, indeed, of all reliable mortality statistics, that the death-rate advances quite steadily with the increasing age of the patients. In Drasche's Vienna Hospital table, an apparently excessive mortality is recorded for the ages from one to twelve years. This is due to the fact that the death-rate of very young children is an extremely high one, and having been included in his computation has resulted in an average that is seemingly above the usual one.

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[1] Washington, 1875, pp. 34, 35.

Statistics of Ages, United States Epidemic of 1873.

AGE.	Arkansas.	Alabama.	Dakota.	Georgia.	Indiana.	Illinois.	Iowa.	Kentucky.	Louisiana.	Mississippi.	Minnesota.	Missouri.	Ohio.	Pennsylvania.	Tennessee.	Texas.	Utah.	West Virginia.	GRAND TOTAL.
Under 1 mo.	..	..	..	..	..	..	..	2	..	..	..	..	..	..	..	..	..	..	2
One month..	..	..	..	..	..	..	..	2	..	..	..	1	..	..	1	..	..	..	3
Two months.	..	..	..	..	..	..	..	1	2	..	..	..	..	..	.	..	..	..	3
Three month	..	..	.	..	..	..	..	2	1	..	..	..	1	..	1	..	..	..	5
Four months	1	..	..	..	..	2	..	..	..	..	..	..	1	..	3	..	..	..	7
One year....	..	4	..	..	4	4	..	21	16	..	..	5	18	..	33	..	..	..	105
Two years...	3	12	..	..	6	3	1	29	16	..	..	11	23	..	68	..	2	..	174
Three " ...	3	13	..	..	3	4	..	20	9	1	1	14	21	..	44	..	..	..	133
Four " ...	..	9	..	..	6	5	..	17	8	..	..	11	7	..	39	..	..	..	102
Five " ..	1	2	2	..	6	4	..	13	9	1	..	11	10	..	34	..	..	..	93
5–10 " ...	2	18	1	..	26	21	1	48	11	4	1	41	42	..	94	..	..	..	310
10–20 " ...	25	28	2	..	40	39	2	231	23	12	2	81	56	..	212	1	..	2	756
20–30 " ...	33	45	..	1	57	71	7	373	108	16	2	147	143	1	541	15	..	5	1565
30–40 " ...	38	74	3	1	70	68	8	355	68	22	1	154	164	3	480	7	..	6	1522
40–50 " ...	19	37	..	..	30	44	8	265	54	10	..	100	105	2	264	7	2	9	956
50–60 " ...	4	22	1	..	21	24	1	165	42	6	..	63	62	..	112	3	..	6	532
60–70 " ..	2	6	1	..	14	16	..	101	14	1	..	34	38	..	66	1	..	5	299
70–80 " ...	..	5	2	..	6	6	..	37	1	..	..	9	6	..	10	..	..	2	84
80–90 " ...	1	1	..	..	1	1	..	6	..	..	1	3	..	..	4	..	..	..	18
113 years....	..	..	..	..	..	..	..	1	..	..	..	..	..	..	..	..	..	..	1
Unknown...	5	7	43	..	151	11	4	24	23	..	..	63	40	..	315	..	..	..	686
Total......	137	283	55	2	441	323	32	1712	405	73	7	746	740	6	2321	34	4	35	7356

These different tables fairly represent the average mortality, and the death rate as influenced more particularly by the age of patients. With regard to infantile mortality they are not accurate. A large experience of many epidemics has shown that up to and below one year of age, the death-rate is frightfully high—generally above 92 per cent., and often reaching 98 per cent.

In old age the death-rate is likewise very high, but less excessively so than in early infancy.

As a matter of course weak, debauched and cachectic individuals of middle life contribute a far larger proportion of deaths than the strong and robust.

Griesinger calculates that in large cities about half the number of deaths are observed in those at the time or recently sick and ailing. On the other hand, Dr. Gairdner mentions that the post-mortem examinations of choleraics in Edinburgh showed very little disease in the bodies of those who died there.

The lower classes, for easily understood reasons, show a higher rate of mortality than the well-to-do and wealthy.

Occupation plays a rôle in the production of mortality only in so far as debilitating work or unhealthful surroundings may vitiate constitutional vigor. Thus Goodeve found in India that the privates and non-commissioned officers of regiments suffered more than the officers. He says further that fatigue, want, grief, fright, have doubtless some degree of influence, though it would be difficult to estimate how much. Of these he considers fatigue the most injurious.

A study of the general mortality of cholera is made additionally interesting by keeping in view the death-rate of the various periods of the disease. It is singular how scanty are reliable statistical records elucidating these points.

Statistics of Sex, Social Condition and Results of the United States Epidemic of 1873.

	Arkansas.	Alabama.	Dakota.	Georgia.	Indiana.	Illinois.	Iowa.	Kentucky.	Louisiana.	Mississippi.	Minnesota.	Missouri.	Ohio.	Pennsylvania.	Tennessee.	Texas.	Utah.	West Virginia.	GRAND TOTAL.
Male........	88	168	10	1	203	179	23	954	252	39	3	420	373	4	1179	27	4	23	3950
Female.....	49	115	2	1	171	144	9	750	153	34	4	267	356	2	875	7	..	12	2951
White......	69	151	12	2	353	312	32	1351	217	32	7	624	687	6	1229	33	4	33	4854
Black......	68	132	..	..	21	11	..	653	188	41	..	63	42	..	825	1	..	2	2047
Married....	55	129	5	2	212	183	15	979	203	30	2	314	354	5	930	9	1	28	3456
Single.....	80	153	5	..	148	108	17	672	174	27	5	311	293	1	930	22	3	6	2955
Widowed...	2	1	2	..	14	27	..	53	6	5	..	40	39	..	66	3	..	1	259
Condition in life unkn'wn	...	...	..	..	....	5	..	....	22	11	..	22	43	..	128	..	..	..	231
Recoveries. White. Male..	22	54	7	..	112	39	8	342	33	14	..	99	171	1	488	10	..	11	1411
Recoveries. White. Female	12	28	1	..	91	27	5	246	37	5	2	24	187	..	332	4	..	2	1003
Recoveries. B'ck. Male..	19	15	..	..	2	....	..	137	19	7	..	13	12	..	221	..	..	..	445
Recoveries. B'ck. Female	10	5	..	..	5	1	..	124	9	14	..	5	5	..	173	..	..	..	351
Deaths. White. Male..	25	38	3	1	81	132	15	264	93	8	3	279	180	3	237	16	4	11	1393
Deaths. White. Female	10	31	1	1	69	114	4	199	54	5	2	222	149	2	172	3	..	9	1047
Deaths. B'ck. Male..	22	61	..	..	8	8	..	211	107	10	..	29	10	..	233	1	..	1	701
Deaths. B'ck. Female	17	51	..	..	6	2	..	181	53	10	..	16	15	..	198	..	..	1	550
Record incomplete. Cases...	...	...	43	..	67	....	..	8	....	..	..	59	11	..	267	..	..	..	455
Record incomplete. Recov's.	...	...	1	..	56	....	..	....	....	..	.	4	....	..	255	..	..	..	316
Record incomplete. Deaths..	...	...	42	..	....	....	..	....	....	..	..	55	....	..	12	..	..	..	109
Record incomplete. Unk'wn	...	...	..	..	11	....	..	8	....	..	..	....	11	..	....	..	..	..	30
Tot. Recov's	63	102	9	..	266	67	13	849	98	40	2	145	375	1	1469	14	..	13	3526
Total Deaths	74	181	46	2	164	256	19	855	307	33	5	601	354	5	852	20	4	22	3800
Tot. Results Unknown.	...	...	..	..	11	....	..	8	....	..	..	....	11	..	....	..	..	..	30
Grand Total.	137	283	55	2	441	323	32	1712	405	73	7	746	740	6	2321	34	4	35	7356

A table based on 805 cases under the personal observation of Drasche was published by him in 1866, and is here reproduced:

Death-rate at Different Periods of an Attack.

AGE.	No. of Cases.	Mortality During the Period of Active Discharges.	Recoveries after the Period of Reaction.	Deaths During Typhoid Condition.	Recoveries During Typhoid Condition.	Death-rate of Cholera-Typhoid	
						Died.	Recov'd.
	Per cent.	Per cent.	Per cent.	Per cent.	Per cent.	Per cent.	Per cent.
1 to 10 years................	32	34.3	25.	34.3	6.2	84.6	15.3
11 " 20 "	165	22.4	50.3	15.1	12.1	55.5	44.5
21 " 30 "	248	29.	44.7	16.5	9.6	63.	37.
31 " 40 "	147	36	37.4	15.6	10.8	58.9	41.1
41 " 50 "	78	48.7	28.2	14.1	8.9	61.1	38.8
51 " 60 "	76	55.2	9.2	28.9	6.5	81.4	18.6
61 " 88 "	59	66.1	5.	28.8	0.	100.	0.

From an examination of this table it appears that death occurred in 36.2 per cent. of all cases during the period of active discharges; death took place in the typhoid condition in 18.6 per cent. of the cases. Recoveries after reaction amounted to 35.9 per cent. and after the development of typhoid symptoms to only 9.1 per cent.

The high mortality of cholera-typhoid is likewise apparent from the figures of Pfenfer, who places the death-rate at 59 per cent.; Leubuscher who records 67 per cent., and of Lübstorff who saw 71 per cent. die.

The time of death is well shown by examining the mortality of the first Parisian epidemic. 4,907 fatal cases were reported. Of this number there died after the disease became established:

204 cases in from 1 to 6 hours.
615 " " 6 " 12 "
392 " " 12 " 18 "
1173 " " 18 " 24 "
823 on the 2d day.
503 " " 3d "
382 " " 4th "
240 " " 5th "

125 on the 6th day.
79 " " 7th "
171 " " 8th "
35 " " 9th "
36 " " 10th "
111 between 10 and 14 days.
19 in the third week.

According to English reports the average duration of an attack may be put down as 6 days. In fatal cases the average was found to be (London 1854) 2.68. In cases ending in recovery the average duration of the disease was ascertained to be 9.06 days. This illustrates a common prognostic experience, namely that the longer the fatal issue can be held in abeyance, the better are the patient's chances of ultimate recovery.

CHAPTER XXX.

THE COMPLICATIONS AND SEQUELÆ OF CHOLERA.

An attack of cholera occurring in a previously healthy person is ordinarily so quickly decided that there is little time for the development of complications. In the stage of reaction, however, the march of events is comparatively slow, although we have already seen that in scarcely any other disease do we find such marvelous changes from an apparently hopeless condition to one of safety and relative well-being. On the other hand the profound circulatory disturbances of cholera may eventuate in numerous local congestions and inflammations, that cannot be discussed seriatim. For this reason only those conditions will receive attention that are known to be of more common occurrence, whereas the rarer forms of sequelæ will be merely mentioned in passing. The condition of the patient at the time of the attack must necessarily influence to some extent the course of the disease. It is especially during or at the beginning of convalescence that a number of disturbances are apt to arise which require to be separately considered.

In the first place we may speak of

Relapses.—There can be no doubt that reaction may have been fairly established when, from some cause generally escaping detection, a return of vomiting, purging, with cyanosis and collapse, takes place. This is by no means a common event, but when it happens death from coma is a rule that admits of scarcely any exceptions. Temporary derangement of the digestive organs, following some slight error in diet, does not come under the head of actual relapse of the disease itself, although it may sometimes simulate such a condition.

Exanthemata.—During the attack proper cutaneous eruptions are scarcely ever seen. But in the period of reaction and especially as convalescence seems to gain the upper hand, they are of frequent occurrence. In some epidemics they appear in almost every case; in others they are oftener missed than seen. These eruptions comprise about all the known varieties of acute exanthemata. Accordingly we find erythema, roseola, urticaria the various vesicular and papular eruptions. Even pustules resembling variola, and erysipelatous inflammations may be developed. At times the cholera rash may closely resemble that of measles, or scarlatina, while at others there appears a marked tendency to the development of furunculosis and deep ulcerations. Sometimes only a few scattered boils make their appearance.

The appearance of the various simple eruptions is not heralded by morbid manifestations of any kind. A catarrhal hyperæmia of the conjunctiva, throat, or tonsils is in no way peculiar to, and does not regularly precede the cutaneous symptoms.

It is in the second week of the disease, several days after the urine has again begun to flow, that these exanthemata are most frequently observed.

A more or less pronounced general redness of the skin often precedes the distinctly localized eruptions. Occasionally this diffuse redness is accompanied by considerable swelling, in which case the patient may appear to be suffering from erysipelas. But in a few hours, or after a day or two, the redness and swelling vanish, leaving only larger or smaller islands of a bright red appearance scattered over various parts of the body.

In other cases the sequence of events is a different one. Small red spots first appear on the hands or feet. They may grow in size, and then other patches break out upon the neck and trunk.

Even when the exanthema is indistinguishable from urticaria, itching, burning and other disagreeable sensations are rarely mentioned by the patients. Desquamation occurs as in the eruptions of acute exanthematous diseases.

The maculæ fade away after two or five days, and branny scales are shed. In a week the skin has regained its normal appearance. When papules or vesicles have existed, crusts may form after six or eight days. These, of course, are more slowly shed. Or, what is rare, the skin may peel away in large shreds, after an efflorescence resembling scarlatina.

Sometimes the skin shows scattered pigmentations for a longer period as an index of former eruptions.

Of course the occurrence of boils essentially modifies the usual march of events. But it is not necessary to dwell on this complication, which is in no way peculiar to cholera. The post-mortem examination of bodies that showed various efflorescences at the time of death demonstrates the fact that the usual reddish eruption of cholera is due merely to hyperæmia of the superficial vessels, with moderate serous exudation. Much more serious lesions of course characterize the ulcerative processes.

The variable frequency with which the cholera-exanthem appears in different epidemics, is well shown by a table prepared by Drasche, giving the results of numerous observations by careful men.

Frequency of the Cholera Exanthem.—According to

Haller it occurred in	1.	per cent of all cases.
Winge " " "	1.5	" " " " "
Horbye " "	2.0	" " " " "
Harten " " "	2.2	" " " " "
Müller " " "	2.5	" " " " "
Lebert " "	3.1	" " " " "
Von. Hönigsberg "	3.3	" " " " "
Reinhart and Leubuscher	66.	" " " " "
Joseph " "	11.5	" " " " "
Meyer " "	46.3	" " " " "

As regards the clinical significance of the appearance of a cutaneous eruption, the opinions of various authors differ to such an extent that it is impossible from the evidence before us to decide its exact meaning. Nevertheless most of the later writers agree in regarding it as a favorable prognostic sign.

Indeed, Griesinger is inclined to attribute considerable importance to it. For, in his experience, death is rarely seen after a well-marked cholera efflorescence. And a decided improvement of the patient's general condition is often noticed simultaneously with the breaking out of red spots over his body.

Profuse Perspiration.—Attention has already been called to the localized breaking out of cold clammy sweat during the period of attack. In reaction and convalescence profuse perspiration is quite frequent. It is more uniformly distributed over the body than before, and may work beneficially by carrying off considerable quantities of urea. Acting as a vicarious function, it may relieve the kidneys and should be encouraged. It is noticeable too that the sweat may be warm and grateful to the patient. Many times it has been found quite odorous. The abundant presence of urea in this perspiration may become manifest by a well-marked deposition of fine whitish scales upon the surface of the integument.

Diphtheritic and other Inflammations.—Inflammation leading to the formation of false membranes, superficial necrosis, or even deep ulceration is a not uncommon complication or sequel of an attack of cholera.

Various parts of the body may become the seat of morbid changes belonging to the class of diphtheritic inflammations.

The upper air-passages suffer most in point of severity and frequency. But the bronchi, the stomach and bowels, the bladder and female generative organs may all be attacked.

Even upon the skin diphtheritic exudation has been observed. It is unnecessary to give a detailed account of the symptomatology of these affections as modified by the previous attack of cholera which the patient has suffered.

Suffice it to say that it not infrequently happens that life is destroyed by the severity and extent of the diphtheritic inflammation.

Croupous inflammations are much less frequent than those of a diphtheritic kind. Croupous pneumonia may sometimes occur, but generally the pulmonary inflammations are catarrhal and hypostatic. Peritonitis has been observed, but it is quite rare. The symptoms of these secondary processes are naturally not as characteristic and clearly defined as when the same lesions occur as primary diseases. And as the kidneys are, as a rule, more or less damaged, various degrees of uræmic disturbance may be superadded to further obscure the localized diagnosis of sequelæ of this class. There is rarely a sudden invasion of new disease. The rule is that all these secondary processes arise in an insidious manner. They are for this reason not infrequently overlooked.

Ocular Troubles.—Conjunctival injection has already been considered as a symptom of the period of attack. During the later stages of the disease it may persist as a troublesome complication or even lead to more serious inflammatory processes.

Ulceration of the cornea is often observed. It may be limited to one eye, but in numerous instances both eyes are affected. The ulcers may be small, superficial and multiple, or deeper single ulcers arise, that may lead to perforation.

Dr. Goodeve says that corneal disintegration occurs most frequently among the natives of India, but it may be seen in Europeans also. An asthenic state of the system is necessary to its production. The lower segment generally suffers first, which is probably due to the fact that during complete collapse the lower lid falls away from the upper one, causing desiccation of the exposed cornea. This segment then first becomes hazy; in a day or so the surface epithelium is shed, leaving an abrasion. Then there occurs, loss of substance in the deeper layers, resulting in a distinctly visible groove. The other eye may now, if not already affected, undergo the same changes. "In twenty-four hours more the groove in the first eye may have doubled its size. Examined with a lens, the surface of the groove is of a dirty ash color, and opaque, having indeed all the character of a minute slough. The ulcer may spread and penetrate the entire thickness of the cornea, and extend at its margins, but in the majority of cases the patient dies before such extensive destruction occurs."

When the patient recovers, the eyes rarely show permanent serious disfigurement, in spite of the threatening aspect of affairs during the progress of reaction. According to the author cited: "There is first arrest of disintegration, then diminution of haziness and opacity, then cleaning of the surface of the ulcer, which becomes beautifully clear and transparent. Cicatrization follows, perhaps rapidly, and the repair is generally perfect, so that unless the ulcer is very deep, in a few days it is often difficult to discover where the mischief has been. Permanent opacity, hernia of the iris, or staphyloma are rarer than would be supposed."

Aural Affections, in the shape of catarrhs of the external and middle ear are rare. But deafness or hardness of hearing, generally quite temporary in nature, has been described by numerous authors.

Unilateral or double **parotitis,** that may lead to extensive suppuration, is occasionally observed. Rayer saw parotitis four times in 200 cases, Müller three times in 275, but Drasche only five times in 805 cases. The symptoms are like those of ordinary mumps, except when pus is formed. In that case pyæmia has been observed to develop, with a fatal result in almost every instance.

Paresis and **paralysis** follow an attack of cholera less often than they do attacks of other infectious diseases. But that they may occur cannot be doubted.

Gangrene of various parts occurs as a sequel in a certain proportion of cases. When considerable in extent, it may of course lead to death. Ordinarily, however, the mortified parts are only small, and reparative processes cause an early separation of dead from living tissue. Goodeve has seen, among the natives of Bengal, complete gangrene of the penis and scrotum that invariably terminated in death.

Bed-sores, ulcers and other destructive lesions naturally constitute frequent sequelæ, that may cause great suffering, and considerably retard or even jeopardize the establishment of complete convalescence. But they are in no sense peculiar to cholera, and require merely to be incidentally noticed.

Prolonged Gastro-intestinal Derangements.—An irritable or extremely sensitive state of the alimentary canal is often a most persistent sequel even of a comparatively mild attack of cholera. When we remember that the specific infecting agent appears to primarily concentrate its baneful force upon the gastro-intestinal mucous membrane, this peculiarity should not surprise us.

Slight errors in diet often result in serious derangement of the stomach and bowels, long after the patient has successfully overcome the acute disturbance of the attack itself.

In some patients moderate diarrhœa and occasional vomiting persist for days and even weeks, and the slightest provocation will again call forth profuse and weakening discharges.

Some patients, on the other hand, show a tendency to constipation, which it may be dangerous to actively interfere with, except by enemata.

Still others are afflicted with the various forms and degrees of dyspepsia, that may remain for months or even become quite chronic.

Gastralgia, enteralgia, occasional nausea that may or may not lead to vomiting, capricious appetite or anorexia, with an actual impairment of digestive and assimilative power, may at length lead to a pronounced marasmus and debility. It has happened that patients gradually failed from this inability to appropriate sufficient nourishment. And occasionally post-mortem examinations have even revealed actual gastritis.

Careful nursing, however, generally finds its reward in a gradual restoration of digestive power, which seems to show that many of the symptoms above enumerated depend upon functional rather than structural changes, and that actual gastritis is a rare exception rather than a common occurrence, as has been supposed to be the case by some writers.

CHAPTER XXXI.

THE CHOLERA TYPHOID.

THE condition generally known by this name is one of the most common forms of retarded recovery, and may well be separately considered. It has received its designation from a group of more or less prominent symptoms that in some respects resemble those of an attack of typhoid fever.

Before or near the end of the first week the patients, instead of showing the ordinary signs of normal reaction, begin to complain of severe headache, feeling "as if the head were in a vise." There is vertigo and great psychical depression with increasing debility.

In many cases the patients lie quietly on their backs, with half-closed eyes and open mouths. Somnolence is often marked, and on being roused they answer reluctantly and with hesitancy, but in the beginning still intelligently. Later on the somnolence deepens to sopor or coma. No response to questions can then be elicited. Sometimes amblyopia, diplopia, mild hallucinations, tinnitus and other cerebral symptoms precede the sopor. Delirium, agitation and jactatation, the refusal of nourishment and medicines, and similar signs are frequently observed.

In rare instances muscular spasms again arise. Trismus and tetanoid or even epileptiform convulsions have also been noticed, especially in children.

The brain symptoms are associated with a marked febrile movement, which is of short duration, however. The eyes are bloodshot and a creamy substance gathers over the cornea and collects in either canthus. If the eyeball became wrinkled and dry in the stage of collapse, it may now speedily recover its tension and moisture. There is noticeable an unnatural look about the lustrous eyes that baffles accurate description. The pupils are small, and decided photophobia may develop. The pulse may remain normal, but generally it is found somewhat accelerated. Later on it becomes slightly retarded. Pronounced dicrotism is frequent. At first rather full and bounding, it gradually weakens as sopor advances.

Schmidt states that during the cholera typhoid, the blood is again red and fluid, that it coagulates readily, but that it shows a large proportion of urea. The character of the breathing varies considerably. For when the typhoid state develops respiration seems at first much easier; there is absence of præcordial oppression and dyspnœa; the breath grows warm. But later on the respirations become deep, slow and sighing; they lose their rhythm, and may even grow quite labored.

These changes are not accounted for by a physical examination of the chest, which generally reveals only more or less catarrh, with some hypostatic congestion. The latter rarely leads to true pneumonia involving one or more lobes. But disseminated catarrhal inflammations of small extent are not infrequently lit up in both lungs. Hemorrhagic infarctions also occur, but not with great frequency.

The voice may grow stronger again and sound clearer in the early period of the typhoid state, yet it does not fully return to its normal condition, and often completely fades away as the disease progresses. In those cases of cholera-typhoid which are largely due to the retention of urea and other by-products of tissue-metamorphosis, we find a cutaneous deposition of urea over many parts of the body. Even the mucous membranes may show a thin deposit of this urinary ingredient.

The various cholera-exanthemata previously described may all occur in cholera-typhoid. Gastro-intestinal disturbances are always present. The tongue may be moist and furred, or red and glossy, and later it generally becomes dry and covered with dark crusts. It trembles on being extruded from the mouth. There is no appetite and occasional vomiting occurs; the vomited matters are bilious and contain carbonate of ammonia. Hiccough is often an annoying symptom on account of its persistence. Diarrhœa is quite usual. The stools look yellowish or green, and may be more or less distinctly fecal. Flakes of sanguinolent mucus are often seen, and sometimes unmistakable dysenteric discharges occur. In other cases the evacuations are fetid, which generally indicates diphtheritic ulceration. Moderate tympanitis and abdominal tenderness, together with a somewhat enlarged spleen, are other common signs of the cholera typhoid. A fetid discharge from the vagina may show that diphtheritic ulceration exists in the female organs of generation.

There can be no doubt that some of the symptoms characterizing the typhoid state are directly due to uræmic intoxication. But the view which discards all other influences and makes the typhoid condition identical with uræmia pure and simple does not appear tenable, even when upheld by the authority of men like Frerichs. Dietl, Reuss, Griesinger and others have distinctly shown that cholera-typhoid, especially in its milder forms, may be a simple fever of reaction or irritation (*Reizfieber*). The attack of cholera has produced a grave impression upon the entire system; all functional activities have been modified or suspended. In the final revulsion that decides the contest between disease and constitution in favor of the latter, the remaining energies have become exhausted. A condition of profound prostration ensues, while the functions gradually return to the normal standard.

When the typhoid condition of the patient is really the direct result of uræmia, as happens in a goodly proportion of cases, the febrile symptoms are insignificant as compared with the other grave disturbances already described. In such cases there seems to be a flooding of the system with urea produced in excess, rather than a mere retention of ordinary amounts. The kidneys may become so choked up with débris that complete suppression of urine once more takes place. A urinous odor is given off from such patients, and the skin may become covered with an oleaginous sweat, that deposits urea. Unless the kidneys quickly resume their function, and eliminate large quantities of urea, patients in this pronounced condition of intoxication pass from bad to worse and die comatose, after the entire "typhoid" has lasted four days at the utmost.

It may be instructive to compare the symptoms of cholera-typhoid, as described by Reinhardt and Leubuscher, with those occurring in the uræmia of Bright's disease as given in Gull's report:

Cholera Typhoid.

1. Dull pain in head.
2. Dimness of vision, diplopia.
3. Giddiness, drowsiness.
4. Slight wandering of intellect.
5. Spasms, tonic or clonic, of an epileptic form.
6. Pupil normal.
7. No paralysis.
8. Pulse various, sometimes below the average; commonly quickened or normal.
9. Temperature of the skin at the beginning slightly raised; in further course normal; with extremities cool.
10. Tongue moist and furred, and later in the disease, dry and brown.
11. Vomiting, which ceased when the cerebral symptoms became more intense. Evacuations feculent; their consistency various.
12. Frequent excitement and irregular rhythm of the respiratory movement, with stertor.
13. Urine suppressed or small in quantity, and albuminous.

Ordinary Uræmia.

1. Dullness of intellect, sluggishness of manner.
2. Drowisness preceding coma, and more or less stertor, with or without
3. Convulsions. These symptoms being frequently preceded by giddiness,
4. Dimness of sight, and
5. Pain in the head.
6. Quiet pulse.
7. Contracted, or normal pupil,
8. No paralysis.
9. Temperature of the skin natural.
10. Tongue at first natural, afterward dry and brown.
11. Vomiting an early symptom, ceasing when the brain becomes oppressed.
12. Respiration frequently with stertor. Rhythm irregular and quickened.
13. Urine albuminous.

In uræmic cholera-typhoid complete suppression of urine until the fatal issue is no uncommon occurrence. Death then finds the bladder still empty. Generally, however, suppression lasts only a few days, to be followed by the appearance of a small quantity of highly albuminous urine. Still later increased diuresis may alternate with a diminished flow or a return of suppression. Such oscillations mark the uncertainty attaching to prognosis in the condition under discussion.

In 12 out of 42 cases carefully watched by Drasche there was complete suppressio urinæ until death. This suppression lasted 1 day in 2 cases; 2 days in 4; 3 days in 2; 4 days in 2; 5 days in 2; 6 days in 1; and 7 days in 1.

In 11 of the 42 cases there was initial suppression lasting 2 days in eight, and three days in the remaining three cases.

In the other 19 cases there was diminished renal secretion, but no suppression.

The frequency of cholera-typhoid is variable. The following table published by Drasche comprises careful observations made in 805 cases, all occurring in the epidemic of 1855.

AGE OF PATIENTS.	Number of Patients.	Number of Typhoid Cases.	Percentage of Typhoid Cases.
1 to 10 years..........	32	13	40.6
11 " 20 "	165	45	27.2
21 " 30 "	248	65	26.2
31 " 40 "	147	39	26.5
41 " 50 "	78	19	23.0
51 " 60 "	76	27	35.5
61 " 88 "	59	17	27.8

Cholera-typhoid is more apt to occur in women than in men, and it haphaps with greatest frequency in children. Drasche concludes from his personal observations that not quite 28 per cent. of cholera patients develop this condition. It should be stated, however, that Drasche's figures differ from those of other observers. Thus Pfeuffer saw 33.88 per cent. of his cases pass into typhoid, whereas Lübstorff reports only 14.28 per cent. Other writers give still other figures. All in all, a fair average may be computed at about 25 per cent.

As regards the time of development of cholera-typhoid, it is also rather variable. Exact records of 42 cases are published by Drasche. Counting from the first characteristic onset of an attack of cholera, the typhoid became manifest after from two to 11 days.

Time of Occurrence of Cholera-Typhoid.

After the 2d day of the attack....,............................	6 times.
" 3d " "	12 "
" 4th " "	10 "
" 5th " "	4 "
" 6th " "	4 "
" 7th " "	3 "
" 8th " "	1 time
" 10th " "	1 "
" 11th " "	1 "

Inspection of the above tables makes it appear that cholera-typhoid is most apt to arise in those cases where the attack runs a rapid course. It is the graver cases, therefore, that furnish the largest supply of typhoid affections. When reaction takes place after sudden and violent symptoms it is often a typhoid reaction, although as has been previously pointed out a healthy reaction is by no means out of the question.

When cholera-typhoid is not due to or complicated with excessive uræmia, final convalescence may still be protracted for one week, two, or even three weeks. After three weeks, unless extraordinary and exceptional complications exist, there is generally perfect restitution.

CHAPTER XXXII.

PREGNANCY AND CHILDBED AS INFLUENCED BY CHOLERA.

ALTHOUGH strictly speaking pregnancy is not a complication and certainly no sequel of cholera, it seems expedient to consider the subject in this connection, and a brief chapter is accordingly devoted to it. Cholera has often been observed in pregnant women; it does not appear, as has been supposed by some writers, that this condition creates a decided predisposition to the acquisition of the disease. Drasche reports having observed 39 pregnant women out of a whole number of 858 female cholera patients. That is about 4.5 per cent.

In the epidemic of 1855 this careful observer paid particular attention to the subject under consideration. Among 431 female cholera patients, he observed 25 in a pregnant condition. Of these there were

Pregnant in the 9th month	5
" " 8th "	3
" " 7th "	3
" " 6th "	6
" " 5th "	2
" " 4th "	2
" " 3d "	2
" " 2d "	2

In only a single instance was a living child born, the mother making a good recovery from her attack of cholera. In 13 cases a dead fœtus was born, and only five times the mothers recovered. In 11 cases the fœtus was not extruded by abortion, but of this number only three patients recovered with living products of conception. Sixteen of the pregnant women died and nine recovered. It was observed that in "foudroyant" cases an almost immediate cessation of all fœtal movements and cardiac pulsation occurred.

In the later months of pregnancy the fœtus almost invariably died, but in the earlier months life was at times maintained.

Drasche's observations accord so well with those of later writers that it is unnecessary to adduce further evidence regarding the fatality to both mother and child of attacks of cholera.

Still, it is noteworthy that children have at times been born and remained alive, the mother succumbing to the progress of the disease in childbed. It has never been observed that a child was born actually suffering from cholera, even when the mother was almost dead of the disease at the time of birth.

Whether the disease is really communicable from mother to child through the placental circulation is still in dispute, opinions being about evenly divided. Recent investigations have not furnished us with new data that might serve to elucidate or decide the problem.

Mouchet[1] claims to have three times observed the characteristic lesions known as psorenterie in the fœtus.

Dr. Leale[2] says:

> My observations during the months of July, August, and September, 1866, of pregnant women, in a neighborhood where the epidemic prevailed, caused me to conclude that the intense fear of being exposed to the disease, without really having it, may produce a shock sufficient to either kill the fœtus *in utero* or to bring about a premature delivery. Also that an attack of Asiatic cholera, from its violence, may suddenly kill the unborn child, but that, if the mother recovers, she may go until the end of the ninth month of pregnancy, when she may safely be delivered of her macerated dead child. Also that there are other women, of either the delicate or robust organization, who will carry a child until the end of the term, notwithstanding the most fearful commotions. The histories of our wars and epidemics boldly bring this class into view.

Some writers have claimed that the amniotic fluid became rapidly reabsorbed in cholera, but Drasche and other authorities dispute the truth of this statement. The unusual violence of the labor pains of cholera patients may possibly receive its explanation from the general spasms observed in the muscular system of such sufferers. In this connection it is not without interest to remember that in non-pregnant women, uterine spasms resembling dysmenorrhœa, or even simulating labor pains, are not infrequently observed very soon after the development of an attack of cholera.

If the uterus has discharged its contents and the mother survives, the organ contracts quickly and energetically, and rapid involution sets in. Indeed, it has at times been found impossible to detach the placenta on account of the rapidity and violence of the uterine contractions following an expulsion of the child.

Regarding childbed, it seems that the early days of lying-in afford a relative immunity from cholera, the attacks being far more frequent between the first and second weeks than immediately after delivery.

It will be readily understood that whenever cholera complicates puerperal diseases, the patient's chances of recovery are exceedingly slim. From the meager data that are found scattered through the literature of the subject it cannot be decided whether the puerperal state creates a decided predisposition to the acquisition of cholera. Reasoning *a priori* such a predisposition would seem to be quite probable.

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[1] Thése de Paris, 1867.

[2] New York Medical Journal, February 21, 1885.

PART FOURTH.

THE MORBID ANATOMY AND PATHOLOGICAL HISTOLOGY OF CHOLERA.

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CHAPTER XXXIII.

MORBID APPEARANCES AFTER DEATH IN COLLAPSE.

General Remarks.—In giving an account of the morbid anatomy and pathological histology of cholera, it is not intended to describe in detail the numerous lesions that have been from time to time discovered in connection with the disease. Only those changes will receive consideration which, being most commonly found in the post-mortem examination of cholera bodies, may be properly regarded as belonging to the disease.

Yet it by no means follows that even the more common lesions must be invariably present in every case. Indeed, if we remember that cholera sometimes kills within a few hours after its onset, we should not be surprised to find that even some of those changes which are so generally encountered as to appear essential to the disease may, in exceptional instances be altogether wanting. This does not, however, apply to the small intestine, where morbid alterations are invariably found, no matter how brief may have been the duration of the attack.

It is well known that the ordinary autopsical appearances vary in accordance with the stage of the disease at the time of the patient's death. The fatal issue occurs most frequently in collapse or during the period of reaction. And it is precisely during collapse and after reaction that the morbid appearances show the widest difference. Hence it will facilitate our description if we consider them separately under those several heads. Nevertheless, to avoid interrupting the narrative, pathological lesions will be exceptionally described under the first heading that, strictly speaking, should be grouped under the second, and vice versa.

Appearance of the Cadaver.—When death has occurred during the collapse of cholera, the cadaver presents a very characteristic appearance. Rigor mortis occurs quickly, is always well marked and may persist for thirty or even forty hours. The entire body has a peculiarly shrunken aspect. Emaciation may be extreme, and the loss of subcutaneous fat is quite pronounced, except in those rarer cases where death has overtaken the patient after the disease had lasted but a few hours. The integument looks wrinkled and has a ghastly leaden pallor, with deep cyanosis of the distal parts, especially the finger-tips, toes and ears. Large livid cadaveric blotches are seen, especially at the dependent parts of the body.

The countenance is not that of an ordinary corpse. The eyes are deeply sunken in the bony orbit, and generally surrounded with wide bluish-black rings; the chin and nose are sharp; the lips look purplish; the malar bones project prominently, and the temples have an exceedingly hollow look. All the features seem horribly pinched. In a word, the general aspect of the body corresponds in all essential respects to the appearance of the patient in the last hours of life. Cadaveric decomposition is long delayed, and the body grows cold slowly.

Post-mortem Contractions of the Muscles.—The peculiar phenomenon of post-mortem twitchings and contractions of the muscles must here be noticed. Decided movements of this kind have been repeatedly observed. They may occur several minutes or hours after death. Eichhorst[1] mentions a remarkable case in which, three hours after death, muscular contractions occurred in the biceps, and finally the entire muscle contracted, producing decided flexion of the forearm. The daughter of the deceased patient had been much terrified to witness this apparent resuscitation, and Eichhorst being hastily summoned, come in time to observe the contractions, but not the alleged return to life of the man. But it was even to the physician a rather startling post-mortem phenomenon. The mouth has been observed to open and shut from post-mortem muscular contractions. In his "Lectures," Watson describes these singular occurrences in the following manner: "A quarter or half an hour, or even longer, after the breathing had ceased, and all other signs of animation had departed, slight, tremulous, spasmodic twitchings and quiverings and vermicular motions of the muscles would take place, and even distinct movements of the limbs in consequence of these spasms."

Barlow[2] gives an account of these remarkable phenomena, in the case of a man who had quickly succumbed to a violent attack of cholera. The contractions commenced almost immediately after death, in the lower extremities, where the patient had suffered severe cramps during his lifetime. "Not only were the sartorius, rectus, vasti, and other muscles thrown into violent spasmodic movements, but the limbs were rotated forcibly and the toes were frequently bent. The motions ceased and returned; they varied also; now one muscle moved, now many. Quite as remarkable were the movements of the arm; the deltoid and biceps muscles were peculiarly influenced; occasionally the forearm was flexed upon the arm—flexed completely; and when I straightened it, which I did several times, its position was recovered instantly. The fingers and thumbs were now and then contracted, and at times the thumbs were separately moved. The fibers of the pectoral muscles were often in full action; distinct bundles of them were seen at intervals beneath the skin."

In his article on cholera, Stillé[3] says, that "these muscular contractions succeed one another in a regular order, beginning in one lower extremity and extending to the other, then to the upper limbs, and finally to the face. Their degree varies from a slight quivering to a powerful contraction, and their duration is from a minute or less to an hour and a quarter."

This is in complete accord with what Drasche,[4] in his well-known monograph, described as early as 1860. Drasche incidentally alludes to the numerous reports and stories concerning cases of apparent death and alleged burials of living patients, especially during the epidemics of 1830 and 1831, that find their proper explanation in these post-mortem phenomena. It is well, therefore, for physicians to inform the attendants concerning the possibility of such occurrences. Drasche himself witnessed the most fearful confusion and consternation among those surrounding a dead body, on the sudden appearance of muscular contractions. He explains the occurrence of post-mortem ejaculations of semen through muscular contractions in the walls of the vesiculæ seminales.

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[1] Article on cholera in Eulenburg's Real-Encyclopædie der gesammten Heilkunde, 1880.

[2] London Medical Gazette, November, 1849.

[3] Pepper's System of Practical Medicine, 1885.

[4] Die Epidemische Cholera. Von Dr. Anton Drasche. Weir, 1860.

Mention may also be made of those singular cases in which the forearms become so contracted as to cross each other, giving the impression of an attitude of prayer. Indeed the phenomenon has been so interpreted by some of the older writers, and the last moments of a fast fading life have been held to be coupled with the involuntary assumption of an attitude of prayer. The eyes have likewise been observed to open and move in different directions, and a complete turning over of the body on one side has been credibly described.

Powerful muscular contractions of this kind have been at times observed in other diseases as well as in cholera, but with far less frequency. Stillé remarks that "these muscular phenomena after death form an interesting feature in the history of cholera, but they are by no means peculiar to that disease. They have been observed in other diseases, and especially in yellow fever—an affection in which the pathological condition is quite unlike that of cholera. In both diseases they have been manifested in robust persons, and when the course of the fatal attack was both rapid and severe."

He also alludes to the experience of Dr. Dowler, of New Orleans, who found that contractions could be provoked by striking the muscles, in rapidly fatal cases of yellow fever. Dr. Dowler also witnessed their spontaneous occurrence, and describes a noteworthy instance of the phenomenon in question as follows:

"Not long after the cessation of the respiration the left hand was carried by a regular motion to the throat, and then to the crown of the head; the right arm followed the same route on the right side; the left arm was then carried back to the throat, and thence to the breast, reversing all its original motions, and finally the right hand and arm did exactly the same."

Drasche has pointed out that these phenomena never happen in patients who have died in the typhoid stage of cholera. It is not impossible that the ante and post mortem muscular movements may in some measure account for the elevation of temperature which takes place after death from cholera; an elevation, it will be remembered, that may amount to over four degrees Fahrenheit. At

The Necropsy the marked dryness of the subcutaneous connective-tissue, as well as the dryness and deep reddish-brown color of the muscles, are at once apparent. The abdominal viscera likewise appear dry, and sometimes seem almost pressed together, having shrunk deeply back into the abdominal cavity. Of course this is not seen in those cases where the intestines contain an overabundance of fluid. Our attention is naturally first directed to the condition of the alimentary canal. The serous surface of the small intestine looks rosy or purplish, that of the stomach and colon normally pale. There is no distension from gas, but fluid may be found, especially in the ileum, in greater or less abundance. Often the intestines have a flabby, sodden appearance.

The Peritoneum, and especially the serous covering of the intestine, is either quite dry, or else it appears coated with a thin film of a viscid albuminous substance, that on being rubbed produces a soapy scum or lather. Microscopically examined, this substance is found to consist principally of desquamated endothelial cells, which have undergone granular degeneration or mucoid metamorphosis.[1]

The Pharynx and Œsophagus are sometimes found almost normal, but oftener they show more or less congestion of the mucous membrane, with extravasations and ecchymoses varying in extent and degree. The usual slimy coating is replaced by a dry appearance of the inner surface. Only exceptionally do we find a creamy substance deposited in a thin layer upon the lower segment of the œsophagus.

The Stomach is often, yet by no means always, hyperæmic. But the hyperæmia rarely extends to the serous coat. Its mucous surface is coated with a thick layer of viscid mucus, that, owing to the presence of blood, sometimes assumes a brownish-red or even inky look. Bilious contents of the stomach are rarely seen. Sometimes in place of being hyperæmic the gastric mucosa looks abnormally pale. It is a fact that the mucous membrane covering the fundus is, as a rule, found to be more or less softened and relaxed. But in spite of the writings of Rayer,[2] Briquet and Mignot,[3] Tholozan,[4] and others, this softening must be regarded as of post-mortem origin. Tholozan has also described a gastric "psorentérie," brought about by the appearance of small, oval, whitish and friable projections upon the inner surface of the mucosa. Most observers fail to mention appearances of this kind.

The Small Intestine, in addition to the previously noticed subserous vascularity that imparts to the outer coat its rosy tint, often shows more or less congestive swelling of the mucosa. But at times the mucous membrane appears normally or even unnaturally pale. When hyperæmia is well-marked and bloody extravasations have occurred, these conditions are observed to be most pronounced in the ileum, especially as we approach the ileo-cæcal valve. Koch, who has carefully studied the condition of the intestines in cholera corpses, finds the usual text-book description of their appearance insufficient or faulty. In his address on Cholera and its Bacillus, delivered at Berlin, he says:

> There were cases in which the lower section of the small intestine was colored dark brownish red, most intensely immediately above the ileo-cæcal valve, less so higher up, the mucous membrane being studded with superficial hæmorrhages. In many cases the mucous membrane was even superficially necrosed, and showed diphtheritic coatings. Corresponding to this, the contents of the intestine were not a rice-watery colorless liquid, but a bloody, ichorous, stinking fluid.
>
> Other cases showed a gradual transition to less marked modifications. The redness was less intense in them, and finally existed only in patches; and these were followed by cases in which only the borders of the follicles and Peyer's glands were reddened. This last-mentioned item affords a very characteristic appearance, which does not occur in other affections of the intestines, and is quite peculiar to cholera. In comparatively very few cases, however, the mucous membrane was very little changed. It looked somewhat swollen and less transparent in the surface-layers; the solitary follicles and Peyer's glands were strongly prominent. The whole mucous membrane was slightly rose-colored, but there was nowhere any capillary hæmorrhage. In these cases the contents of the intestine also looked colorless, but they were by no means always like rice-water, but would be generally better compared to gruel. Only in a few cases have I seen that the contents of the intestine were purely watery and mucous, and contained comparatively few flakes.

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[1] Straus, Leçons sur l'anatomie Pathol. du Choléra. Le Progrès Médical, December 13, 1884.

[2] Recherches anatomiques sur le choléra. Paris, 1832.

[3] Traité pratique et analytique du choléra. Paris, 1850.

[4] Recherches sur quelques points d'anatomie et de physiologie pathologiques du choléra, Paris.

Macnamara says that he has frequently seen cases in which "the mucous surface of the intestinal canal, like that of the stomach, is pale and exsanguine from one end to the other." Concerning the congested portions, the same author writes: "If a portion of the injected intestine be placed under the microscope, a half-inch power used, and pressure made on the covering glass, it will be observed that the blood contained in the congested vessels is not squeezed uniformly out of the veins, but breaks off into little masses, reminding one of the detached patches of mercury seen at times in a broken thermometer, or other narrow glass tube, conveying the idea that the blood in the vessels, although not formed into a clot, has become thick and tenacious."

Stillé believes that "the general paleness of the intestinal mucous membrane in the stage of collapse, and its congestive redness whenever the signs of reaction have existed before death, have a very important bearing upon the pathology of this disease, for they demonstrate conclusively that the gastro-intestinal evacuations in cholera have no relation whatever to inflammation. On the other hand, they render it altogether probable that the serous flux is in the nature of a sweat, an intestinal ephidrosis."

This view evidently accords with some observations made by Sutton,[1] which were, however, too limited to justify any such wide generalization.

Numerous examinations by other observers show that synchronously with the immense serous effusion there constantly occur changes of a distinctly inflammatory character. If we are to believe Koch, they must be regarded in the light of a specific process due to a bacillary invasion. Hyperæmia, small-cellular infiltration, swelling and granular degeneration of glandular epithelium, ecchymosis, hæmorrhage and even necrosis—all these commonly observed changes clearly show that the intestines in cholera are in a condition of acute specific inflammation. It does not appear possible, therefore, that the "serous flux" has no other significance than that of a non-inflammatory intestinal sweat.

At the recent English debate on cholera, Dr. Pye-Smith[2] compared the rice-water discharge to the paralytic secretion which occurred after division of all the nerves supplying a portion of the gut. He also held that the intestinal lesions of cholera were of a non-inflammatory kind. But his views were evidently not shared by the majority of those who participated in the discussion. Sutton himself has stated that even when "the mucous membrane was pale throughout the entire intestine, the valvulæ conniventes looked swollen and œdematous. The solitary glands were very distinct and prominent. "In imperfect reaction be found the mucous membrane very much congested and ecchymosed." The congested portions were sometimes granular, and apparently denuded of epithelium. The mucous surface had often a dark port-wine color, due to the extravasated blood and the hyperæmia, and here and there the surface was covered with a dirty gray membranous substance, likened to a diphtheritic deposit. I have, however, seen no decided false membrane, such as could be peeled off, as in diphtheria. The surface was also occasionally bile-stained, and the greenish-yellow color of the bile and the deep red color of the congested surface presented a very striking appearance. The solitary glands were very prominent, and in some cases apparently enlarged."

The inflammatory changes as described by Kelsch and Renaut[3] are distinct and unmistakable. These writers mention especially the small cellular infiltration of the mucous and submucous coats. Leucocytes of emigration were also seen beneath the serous coating by these observers.

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[1] London Hospital Clinical Lectures and Reports, vol. iv.

[2] The British Medical Journal, April 4, 1885.

[3] Note sur les altérations histologiques de l'intestin, etc. Progrès médical, 1873.

This round-celled infiltration may affect the solitary follicles and Peyer's patches to such an extent that a striking similarity to typhoid intestines results. Rudnew[1] was struck by this peculiarity as long ago as 1866.

Epithelial Desquamation of Cholera Intestines.—A few words must here be devoted to the mooted question regarding the occurrence and significance of extensive epithelial desquamation in the intestinal canal of choleraics. Formerly it was very generally believed to be one of the most important, if not *the* most important pathological phenomenon of the whole disease. And even at the present day there are those who uphold such views. Thus Dr. Maclagan, at the recent discussion on cholera before the Royal Medical and Chirurgical Society,[2] distinctly asserted that the shedding of the epithelium was the characteristic lesion of cholera, and that the mucous membrane of the alimentary tract was the nidus of the poison.

The intestinal villi and even the follicles have been repeatedly found to be deprived of their epithelium, and shreds of exfoliated epithelial membrane, forming the "rice-water granules," have then always been discovered within the intestinal lumen, throughout its entire extent. Niemeyer likened this condition to that of a portion of integument, from which the epidermis had been raised by a burn. Macnamara often noticed a considerable portion of the epithelium still adhering to the walls of the intestines. But in all his published writings, excepting only his last article on cholera in Quain's Dictionary, he expresses the conviction that this separation of epithelium, was to a great extent an ante-mortem occurrence. Referring to the granular disintegration of the individual epithelial cells, he admits that the change differs in no way from what is observed in ordinary decomposition. But, he says, "there is, nevertheless, this most vitally important distinction between the two—the decomposition, or molecular change in the cells, due to cholera, commences when the patient is in possession of life and vigor; it is the rapid death and destruction of intestinal epithelium during life which is the characteristic feature of this disease, and renders it so deadly." Besides this the epithelium of the nasal passages and mouth, of the pharynx and œsophagus, may be shed in large patches, or may appear almost completely destroyed, and this destruction is also seen in epithelium found elsewhere in the body, as in the kidneys, and other parenchymatous organs. It is curious to note that Macnamara for a long time did not hesitate to ascribe this extensive epithelial alteration to post-mortem changes, in all the organs of the body save the intestines, where of all other places, it would be most likely to occur. There is no doubt, in the opinion of the editor, that the intestinal exfoliation is mainly but not entirely due to cadaveric changes. Cohnheim and his followers went further than this, and asserted it to be solely due to cadaveric decomposition.

Flint[3] almost completely agrees with Cohnheim stating "that there is no ground for assuming that during life an extensive desquamation of the epithelium takes place." At the present writing Macnamara and many other competent authors entertain the view that such desquamation is largely the result of post-mortem change, in which opinion the editor has already expressed his concurrence. Apropos of this subject we may be permitted to here introduce the following quotation from Stillé:

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[1] Quoted by Straus in le Progrès médical, December 13, 1884.

[2] The British Medical Journal, April 4, 1885.

[3] A Treatise on the Principles and Practise of Medicine. 1881, pp. 554

> As long ago as the first American epidemic of cholera (1832-35) Dr. W. E. Horner, Professor of Anatomy in the University of Pennsylvania, described an exfoliation of the epithelial lining of the alimentary canal, whereby the extremities of the venous system of the part are denuded, as being characteristic of cholera alone. In 1849, Dr. Samuel Jackson, Professor of the Institutes of Medicine, and Dr. John Neill, Demonstrator of Anatomy in the University, in conjunction with Dr. William Pepper and Dr. Paul B. Goddard, presented a report to the College of Physicians of Philadelphia, in which they too showed that the epithelial layer of the intestinal mucous membrane was either entirely removed or was detached, adhering loosely. This important fact—the most important, perhaps, in the mechanism of cholera—was confirmed seventeen years later by the eminent pathologist Dr. Lionel S. Beale,[1] who, when referring to "the remarkable characters of the matter discharged from the intestinal tube, and to the fact that the small intestines almost always contain a considerable quantity of pale almost colorless gruel, rice, or cream-like matter," added: "This has been proved to consist almost entirely of columnar epithelium, and in very many cases large flakes can be found, consisting of several uninjured epithelial sheaths of the villi. . . . In bad cases it is probable that almost every villus, from the pylorus to the ilio-cæcal valve, has been stripped of its epithelial coating during life. . . . These important organs, the villi, are, in a very bad case, all or nearly all left bare, and a very essential part of what constitutes the absorbing apparatus is completely destroyed. . . . It is probable that the extent of this process of denudation determines the severity or mildness of the attack. . . . It seems probable also that the epithelium may become detached in consequence of the almost complete cessation of the circulation in the capillaries beneath, but the death of the cells may occur in consequence of their being exposed to the influence of certain matters in the intestine or in the blood, in which case they would simply fall off.

The *glandular structures* of the small intestine, as already intimated, show varying degrees of morbid change. The solitary follicles are uniformly enlarged, opaque, hard, and seemingly filled with an amorphous finely granular exudation (Reinhardt and Leubuscher).[2] Peyer's patches, and Brunner's glands are found to be similarly affected. Peyer's patches also show more or less distinctly the congestion already alluded to in the description given by Koch. They have at times been found in a condition of superficial ulceration, not unlike that of typhoid fever. On account of the great prominence of the solitary follicles, the French speak of the intestinal appearance in cholera as a *psorentérie*. Microscopically examined, the almost complete absence of the epithelial lining of the mucosa is readily observed. In addition there is constantly seen a small cellular infiltration of the mucous membrane that, in spite of the contrary statement of Kelsch, only exceptionally extends below the *muscularis mucosæ*. But this does not apply to the lower end of the ileum, where the inflammatory infiltration is seen to have penetrated far into the submucous tissue. Straus[3] characterizes the intestinal lesions of cholera as an "acute desquamative enteritis."

The Large Intestine is frequently found in a collapsed condition. There occur in it scarcely any constant changes. Indeed it is a singular circumstance that the colon has at times presented a perfectly healthy appearance. Generally, however, the solitary follicles and agminated glands are seen to be swollen, hard, opaque and filled with fluid or sticky contents.

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[1] Medical Times and Gazette, August, 1866.

[2] Virchow's Archiv, vol. xi., 1849.

[3] Le Progrès Médical, December, 13, 1884.

Their prominence gives rise to the same condition of *psorentérie*, just mentioned in connection with the small intestine. But an inflammatory infiltration of round cells is not observable in the coats of the large intestine.

The Mesenteric Glands are moderately enlarged, soft, and somewhat congested. Virchow found in them an exudation which looked white and granular, resembling the milt of herrings. Macnamara asserts that this whitish appearance is due to molecular matter carried by the lacteals from the intestine to the lymph-glands. Straus found the mesenteric glands sometimes normal in size and appearance, at other times slightly increased in volume and hyperæmic.

The Thoracic Duct and lymphatics generally are found empty, and show no noteworthy alteration.

The Spleen is commonly found small and shrunken, with a wrinkled capsule, and flabby parenchyma. Buhl observed a milky fluid filling the Malpighian bodies, and Reinhardt and Leubuscher noticed hyperæmia and extravasations. Infarctions have at times been discovered. Straus emphasizes the point that, contrary to what is observed in most infectious diseases, the cholera spleen is diminished in size, shriveled, and of firm consistency rather than soft and pulpy.[1]

The Liver is rather small, pale brown, flacid and quite anæmic, only the portal veins being at times filled with dark blood. The acinous markings are generally very indistinct. Straus[2] says that the liver always presented to the naked eye grayish dirty yellow spots scattered over the surface. They were also seen in the substance of the organ. On microscopical examination the trabeculæ of the hepatic cells were found somewhat separated from each other, and here and there had in part lost their radiated arrangement; the capillaries were distended and filled with red blood globules. The hepatic cells themselves were granular and presented a condition of proteinous infiltration, much less marked, however, than that of the renal epithelium. A certain number of the nuclei were increased in size sometimes to double that of the normal. The epithelium of the hepatic ducts was intact.

MM. Hanot and Gilbert have recently discovered in certain cases little islets in the hepatic lobules which are incapable of receiving any staining.[3] These islets are formed of swollen hepatic cells, with transparent glassy-looking protoplasm, but with nuclei normally stained. They propose for this alteration the name of transparent tumefaction.

MM. Nicati and Rietsch[4] have also described hepatic changes which they believe to be always present in cholera. They say that the liver was more or less atrophied, the lobular contours were effaced, and the cellular trabeculæ within the lobules were markedly widened. They also allude to the distention of the gall bladder and of the cystic, hepatic and common ducts; the latter was narrowed as it entered the intestine, so that very considerable force was sometimes necessary to cause the bile to pass through. Crystalline needles were found in the blood of the vena cava, and the fresh liver presented on section an abundance of fat drops and colorless crystalline accretions. The amount of glycogen in the liver was considerably diminished. In individuals dead in the algid stage the bile was inspissated and black in color. There was often a total absence of bile in the intestine.

The *gall-bladder*, as just described by Nicati and Rietsch, is filled, often to distention, with thin brownish or green fluid. Reinhardt and Leubuscher have observed pus and detached epithelium mixed with its biliary contents.

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[1] Le Progrès Médical, February 14, 1885.

[2] *Ibid.*

[3] Comptes Rendus de la Soc. de Biologie, No. 41, 1884, p. 685.

[4] La Semaine Médicale, No. 41, 1884.

The Kidneys.—Aside from the intestinal lesions of cholera the most important morbid alterations are found in the kidneys. Lebert has made a careful study of these organs as affected by the disease, and Virchow as well as Reinhardt and Leubuscher have also paid special attention to them.

Beginning with active congestion, the tubules quickly undergo cloudy swelling that eventuates in fatty degeneration.

In cases that have proved fatal within a few hours the kidneys show only moderate hyperæmia, principally in the venules near the cortex, and incipient cloudy swelling of the tubular epithelium.

The extensive desquamation of renal epithelium, and plugging up of the lumina of many tubules, which have been described by some writers as characterizing this early stage, is certainly due in most cases to post-mortem changes.

When the disease has lasted twenty hours or more, the kidneys show parenchymatous changes in varying degrees of intensity. Still later fatty degeneration may become quite pronounced. The affection is irregularly disseminated throughout the diseased organs, in such a way that healthy tubules are found side by side with others far advanced in degeneration.

Lebert says regarding the morbid affection of the kidneys: "These organs may early take part in the process of the disease. Even in cases in which death occurred in from sixteen to twenty-four hours after the attack, I have always observed an increase in the volume of the kidneys. At the same time I found them generally filled with blood, in the form of stripes and punctated injection in both the cortical and medullary substances, and on the surface in more star-shaped and marbled spots, with numerous and thick anastomoses. The superficial intercanalicular vessels and capillaries of the Malpighian glomeruli also shared in this condition of congestion, and ecchymoses in different regions were likewise not infrequent. Even in cases of death in the second half of the first day, I have often found the cortical substance of the kidneys in an unmistakable condition of commencing decoloration, extending even from the surface deep down into the pyramids. I have also often seen the capsules abnormally adherent at this time. The microscope reveals at this early stage a remarkable epithelial proliferation in the urinary tubules with cloudy swelling of the cells, the contents of which, consisting of numerous albuminoid granules, may be dissolved by acetic acid. Now and then I have also found, as early as at the end of the first day, distinct transparent cylinders in the interior of the urinary canals. The kidneys, therefore, are decidedly affected on the very first day of a pronounced attack of cholera."

The Bladder is generally found empty and collapsed. At times its mucous surface shows a creamy coating of degenerated and detached epthelium. Hyperæmia about the neck of the bladder is occasionally present.

The Ureters are frequently hyperæmic, and likewise have a somewhat creamy coating, that has no special significance. The appearance of the renal pelvis and calyces has already been mentioned.

The Uterus commonly contains sanguinolent mucous or pure blood in clots. Its mucous membrane is often much congested, and mottled with spots of extravasation, varying in size from a pin's head to large blotches, that may seem to cover nearly the entire surface.

Infarctions, with their broad base turned inward, have been repeatedly seen in the muscular parenchyma of the womb.

The Ovaries show more or less hyperæmia that seems to keep pace with the same condition of the uterus. Bloody extravasations have been found in the substance of these organs.

The Vagina exhibits the same tendency to bloody suffusion and ecchymosis that is witnessed in connection with the other portions of the female generative apparatus.

The Pericardium, and especially the **Pleura,** looks dry, but often has a thin coating that is in all respects similar to what has been already described as covering the peritoneum. Ecchymoses are a frequent occurrence, principally in the dependent portions.

The Heart is firmly contracted in its left compartments, less so on the right side.

The left ventricle, and at times the entire organ, contains little or no blood. Usually, however, the right auricle and ventricle are filled with dark clotted blood. A separation of buffy clots does not invariably happen, but it is the rule nevertheless.

The muscular substance of the heart is firm, red, and hard. Fatty degeneration is not present.

Buhl[1] has ascertained that the loss in water is less in the cardiac muscle than in the other muscles of the body. Heart muscle also contains a smaller proportion of urea.

The endocardium sometimes shows a few ecchymoses. Regarding the *blood-vessels,* it is at once apparent that there is arterial depletion and venous filling, though even the latter is but rarely pronounced, owing to the reduction of the entire volume of blood. The perivascular deposition of reddish-brown pigment is, according to Buhl, a constant occurrence in cholera. Pigment is also found in the walls of the vessels.

Lehmann[2] and especially Schmidt,[3] have made careful studies regarding the

Condition of the Blood in cholera. Schmidt ascertained that the inspissation of the blood was at its height about thirty-six hours after the onset of the pronounced disease.

At that time the proportion of solids may be one and a half times greater than normal. This remarkable increase belongs chiefly to the organic ingredients of the blood. So far as the solids are concerned the loss through transudation mainly belongs to the sodium chloride. Hence the potash salts and phosphates appear relatively increased. Urea also accumulates in the blood, owing to the renal disturbances above described. Nevertheless, Lebert was unable to demonstrate in the blood of patients dying in the typhoid stage, an increase of either urea or carbonate of ammonia.

Quite recently M. Straus has published an interesting account of a series of investigations regarding the blood in cholera,[4] of which the following is a summary: The gross appearance of the blood after standing for about twenty-four hours is very similar to that of infectious diseases or of asphyxia. It is of a deep black color, and covered by a layer of clear, not coagulated, serum. On microscopical examination the red globules appear pale, diffluent, but not agglutinative, as is the case in the blood of malignant pustule. There is also a great number of globulins or microcytes, that is to say of red globules two or three times smaller than normal (Hayem). Owing to the draining away of the serum the relative proportion of red globules is greatly increased, so that one cubic millimetre contains over 7,800,000 instead of 4,000,000 to 4,500,000 which is the normal proportion (Kelsch and Renaut).[1] The reaction of the blood is usually slightly acid. When fresh blood taken from a cholera patient is examined under a high power, there may be seen in the spaces between the globules some extremely minute corpuscles, very feebly refractive and slight, often elongated and narrowed at the center, and resembling micro-organisms.

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[1] Zeitschrift für rationelle Medizin, 1855.

[2] Physikalische und chemische Studien ueber die Cholera. Zürich, 1857.

[3] Charakteristic der epid. Cholera, etc. Leipzig, 1850.

[4] Le Progrès Médical, February 14, 1885.

Indeed they were at first supposed to be such, until further tests by staining and cultures proved the incorrectness of the assumption. At the request of Straus, Dr. Malassez examined a number of specimens of dried blood from cholera patients, and made the following report which had not hitherto been published by him:

"There are frequently found in the blood of cholera patients very minute bodies which might readily be taken for micro-organisms. When the blood is exposed in very thin layers on a slide rapidly dried, then hardened by heat or chromic or osmic acid, and finally stained by gentian violet and mounted in balsam, these bodies are brightly stained and may be seen under various forms and sizes. Many resemble dumb-bells, or diplococci, the individual micrococci of which are separated at some distance from each other and united by a more or less clearly visible filament; others are like a wallet or a biscuit, as if they were micro-organisms in process of division; others again form chains or filaments of varying length. In brief, they might be supposed to be different shapes of the same micro-organism or different varieties of microbes. But they are not. If a little water be added to a specimen of the blood which is simply dried but not hardened, the red globules may be seen to lose color and finally to disappear, their hemoglobine being dissolved. And the apparent micro-organisms comport themselves in the same manner; some indeed resist for a considerable length of time, but may be finally observed to disappear. This disappearance of the red globules and of the minute bodies just described occurs much more rapidly if ammoniated water or a solution of bile be used instead of simple water. When treated in other ways they are also found to act like the red globules, receiving exactly the same staining as the latter bodies, and differing in this respecct from the globulins of Donné (known also as the elementary corpuscles of Zimmermann, hematoblasts of Hayem, and blood "plaquettes" of Bizzozero), and from both the protoplasm and the nuclei of the white corpuscles. There is, therefore, reason to conclude that the little bodies in question are simply portions of red globules drawn out and broken up, an alteration which is perhaps due to the extreme degree of concentration of the blood. The members of the French mission to Egypt reported having found in the blood of cholera patients very minute bodies which bore a resemblance to the lactic ferment. It was probably some of this globular débris that they saw, and not the "blood plaquettes" as Koch asserted in his fifth report.[2] These ' plaquettes " (hematoblasts of Hayem) bear no resemblance to the bodies above described either in form or in size or in their histochemical reactions."

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[1] Le Progrès Médical, 1873, p. 210.

[2] Fortschritte der Medicin, 1884, No. 5.

It may be seen from this how numerous are the sources of error in those delicate researches in hematology; and how cautious one should be in asserting the presence of micro-organisms in the blood, when the fact is not established positively by staining, and especially by culture experiments. It is creditable to Straus to have made so candid an admission of his error, after he had himself claimed for these pseudo-organisms the importance of a new and perhaps valuable discovery.

The Lungs are found collapsed and shrunken. When the thorax is opened they appear to lie far back, as if pressed against the spine. They are dry and generally pale in their anterior and upper portions. The cut surface here looks pinkish or gray. Dark blood oozes slowly and sparingly from the larger veins.

Posteriorly there may be more or less hypostatic congestion and œdema. The pulmonary tissue there is friable, contrasting in this respect with the toughness of the other portions of the lung. The actual weight of the organs may be reduced to one-half the normal standard.

In about fifty per cent. of the cases examined by Sutton, he found the lungs congested throughout, and of a dark red color.

Macnamara reports out of a whole number of sixty-four post-mortems, of which he has kept careful notes, pulmonary congestion thirty-six times. This was when death had occurred in collapse. Dr. Chuckerbuty[1] found the lungs congested in more than one-half of his cases.

In 1854 Baly and Gull,[2] stated that the hypostatic engorgement was, in some instances, so profound as to cause portions of the lung to sink in water.

On the other hand, Parkes[3] said that "the most common appearances in the lungs are the collapse and the deficient crepitation, arising from the more or less complete absence of air and blood."

As regards the **Larynx, Trachea, and Bronchi,** they show little alteration save some pallor or lividity of their mucous surfaces. At times, however, exceeding dryness, at others a slight coating of frothy fluid, and again, patches of hyperæmia and even ecchymosis have been observed.

The occurrence of diphtheritic and pseudo-membranous processes has been recorded by Lebert and others. But all such changes are secondary and do not belong to the specific cholera-process. Moreover, they have been only quite exceptionally seen after death during collapse.

The Diploe.—On opening the cranium the diploë presents an unusually red appearance. Like other osseous structures it is found to be abnormally friable.

The Meninges are seen to be gorged with dark blood; in the sinuses of the dura this is especially prominent. A few extravasations are found here and there, at the base or over the cortex.

The arachnoid often shows a viscid coating, and appears moist and sticky, whereas the *pia mater* is generally dry. At times, however, it appears œdematous and studded with patches of ecchymosis. The ventricles of the brain are either empty or only moderately distended. The *cerebro-spinal fluid* is absent or diminished, and, when present, more sticky than normal. According to Voit the encephalic fluids, either those belonging to meningeal œdema or those found in the ventricles, and even the substance of the brain, contain the largest relative accumulation of urea discoverable in the bodies of cholera patients. Lehmann and Buhl have confirmed these observations.

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[1] Indian Annals, 1867.

[2] Reports on Epidemic Cholera. Drawn up at the desire of the Cholera Committee of the Royal College of Physicians. London, 1854.

[3] Researches into the Pathology and Treatment of Asiatic Cholera. London, 1847.

The Encephalon is drier than normal, especially the white substance. Punctate hyperæmia is at times observed. Buhl also found pigmentary deposits in the smaller cerebral blood-vessels.

The Spinal Cord shows the same meningeal hyperæmia that exists in the brain, and in all other respects its condition corresponds to that of the encephalon. Buhl states that he has found the pneumogastric nerve surrounded with a plexus of dilated blood-vessels, at its point of entrance into the chest. He also describes a hyperæmic condition of the ganglia of the sympathetic. The solar plexus is frequently reddened throughout, and occasionally shows ecchymosis.

These appearances are not without interest, especially when considered in connection with Chapman's peculiar views on the neurotic origin of cholera, fuller reference to which will be found in the chapters on etiology.

CHAPTER XXXIV.

MORBID APPEARANCES AFTER DEATH FOLLOWING REACTION.

It is but natural that the post-mortem appearances are found to vary in accordance with the time that has passed between the first establishment of reaction and the death of the patient. Should the latter occur at the very incipience of reaction, there will be little or no difference from what is seen in death from collapse. On the other hand, after death during or following fully established reaction, some noteworthy modifications of the appearances characterizing collapse are constantly observed.

In the first place the **General Appearance of the Body** is much less shrunken indeed there may be apparent plumpness. Rigor mortis is far less pronounced; it also begins later and ends sooner. Lividity, cyanosis, and extensive cadaveric blotches are less marked and not infrequently absent. A post-mortem rise of the temperature does not take place. Muscular contractions are not observed after death. In a word, there is nothing decidedly characteristic about the external appearance of a cholera corpse, when reaction was fully established at the time of death. The lips, teeth and gums show a dark brown or blackish scum, and often a thick creamy substance coats the conjunctivæ.

On opening the cadaver the connective tissue is found of natural moisture, the blood is again more fluid; the muscles, however, are still dark, dry, and hard. According to Hamernjk[1] an urinous odor often issues from the cut organs, a statement that has been in turn denied and accepted by other writers. At times the buccal mucous membrane, the palate, pharynx and larynx, are found coated with grayish diphtheritic membranes, which reveal underlying ulcerations. Generally, however, the upper respiratory passages present a nearly normal appearance.

The Peritoneum is but rarely injected and covered with products of inflammation. It has regained its natural moisture. A viscid scum is not seen.

The Stomach is commonly found somewhat contracted, holding a moderate amount of dirty-looking fluid. Its mucous membrane may be injected and in a catarrhal condition. A croupous exudation has been described by Pirogoff[2] and others, but its presence is quite exceptional. The "patches of denuded mucous membrane, resembling in apppearance superficial ulceration of this organ," together with "numerous pus-like cells—abortive epithelial products, which have been ineffectually formed to supply the lost epithelium,"—these appearances which are made so much of by Macnamara, are doubtless largely the result of cadaveric changes, although as will appear presently, diphtheritic processes with tissue-necrosis may occur in certain cases. But even then they are found in the intestine rather than the stomach.

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[1] Die Cholera epidemica. Prag, 1850.

[2] Anatomie pathologique du Cho!éra. St. Petersburg, 1849.

The Small Intestine does not contain rice-water or gruel-like fluid, but gas is usually present in some abundance. The internal surface is coated with bilious mucus. When this is removed the mucous membrane may be found apparently normal, or faintly injected. Low down in the ileum, and quite generally in the colon, the presence of fecal matter is noticed. But this is not the invariable condition of things. When death has supervened after a prolonged typhoid condition of the patient, the small intestine generally shows very decided and advanced lesions. Engel[1] and Hamernjk[2] found extensive superficial destruction of the mucosa, producing the appearance of a network with wide meshes.

Reinhardt and Leubuscher describe appearances resembling dysenteric intestines, with the usual hyperæmic condition, diphtheritic membranes, necrosis, and jagged ulcers. (The latter in rare instances have led to perforation and peritonitis.) Bouillaud[3] observed decided gangrene in only one instance out of a large number of cases.

The Large Intestine.—According to Griesinger, diphtheritic or dysenteric ulcerations are not infrequently encountered in the large intestine. The solitary glands are commonly involved in this destructive process. The same writer also observed similar changes in the small intestine, and he says that when Peyer's patches were affected, the resemblance to typhoid intestines was so complete as to be misleading. Yet these secondary lesions are in no way characteristic of cholera. They are mentioned here, however, because some writers have laid much stress on their occurrence. A singular circumstance connected with them is their relative frequency in some epidemics, and their almost entire absence in others.

The Mesenteric Glands appear but slightly enlarged, except in those cases where destructive lesions in the intestine are far advanced, when they may be much swelled and congested.

The Spleen has regained its normal appearance, or is increased in volume, hyperæmic, and soft. Its color is quite generally darker than in the stage of collapse. Infarctions have been repeatedly observed, but must nevertheless be regarded as exceptional. Splenic rupture, as reported by Niemeyer and others, is a rare accident.

The Liver has resumed a darker and more natural appearance. Tholozan[4] asserts that he found it congested in one-half of his cases. He also noticed softening. This statement is at variance with the observations of the majority of competent writers, who agree in pronouncing the liver substantially normal after death during the period of reaction. The *gall-bladder* is only slightly or not at all distended with fluid. At times its mucous membrane is in a catarrhal state. Ecchymoses, diphtheritic patches, ulcerations and even perforation have been described by Pirogoff.[5] But they are exceptional occurrences.

The Kidneys, while showing no single constant lesion, are nevertheless always more or less altered. At times there is merely hyperæmic swelling, with slight parenchymatous degeneration. Frequently, fatty changes of the tubular epithelium are pronounced and widespread, particularly so in the cortical substance. Many tubules are seen to be filled with casts or epithelial débris.

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[1] Prager Vierteljahrschrift, vol. iii., 1851.

[2] Op. citat.

[3] Quoted by A. Mouchet, Observations d'accidents gangreneux, chez es cholériques, in Archives générales, 1867.

[4] Op. citat.

[5] Op. citat.

In a considerable proportion of cases, the changes are those of acute infectious nephritis, with an unmistakable resemblance to the scarlet-fever kidney. This circumstance is in agreement with the clinical fact that cholera convalescents are but rarely known to develop chronic albuminuria. Still Hamernjk and others have reported a few cases, illustrating the possibility of such an event.

The descriptions of Leubuscher, Reinhardt, Virchow, Drasche, and indeed most of the earlier writers on cholera, are inadequate as regards he pathological histology of these interesting renal lesions. And Eichhorst,[5] writing in 1880, publishes a very meager account of them. Griesinger,[2] Laveran[3], and especially Lebert[4] give more satisfactory descriptions.

But it is not necessary to reproduce the views of these various writers here, in order to point out wherein their opinions differ and in what respects there is substantial agreement among them. Quite recently, however, Straus[1] has made careful and elaborate investigations regarding the renal alterations of cholera. The great interest and importance of the subject warrants our presenting a summary of his researches.

In order not to interrupt the continuity of his descriptions, it has been thought advisable to consider the renal changes found by him after collapse, together with those of reaction, that alone properly belonging here.

Straus did not find the increase in the size of the kidneys of those dying during algid collapse or shortly after, which several authors have described. Like Bartels, he generally saw a diminution of volume. The capsule was not adherent, except when there was antecedent renal disease. On longitudinal section he finds the cut surface moist, the cortical substance of a dull grayish red color, with here and there points showing congestion and others of a yellowish brown color. The glomeruli are readily visible to the naked eye, prominent and congested, with the interlobular vessels presenting as sunken lines. The medullary rays of the cortical substance present a dull grayish color, contrasting with the deeper tint of the pyramids. The vascular arches of the intermediate substance are strongly congested. Pressure made with the back of the scalpel upon one of the papillæ causes an exudation of a suspicious looking fluid resembling pus. The mucous membrane of the pelvis is sometimes pale and sometimes strongly congested, and of a bluish or violet color.

Examined under the microscope, the epithelium of the convoluted tubules is seen to be profoundly altered even in very acute cases in which death has occurred in from twenty-four to thirty-six hours after the commencement of the disease. The cell markings are effaced and Heidenhain's striation is not present. The protoplasmic substance is swollen and contains irregularly shaped granules of varying size, refractive to light, and colored brown by osmic acid, the cloudy swelling of Virchow. In consequence of the cellular tumefaction, the lumen of the secretory tubules is almost completely effaced, while their diameter is greatly increased. The free border of the secreting cells is uneven and irregularly torn, as if it had been nibbled. When the disease has been of somewhat longer duration (from one to three days), this ragged appearance of the border is more marked, and the protoplasm is reduced to the condition of an irregularly granular substance. It is only in exceptional cases that the little colloid spheres described by Cornil in acute or subacute nephritis and in poisoning by cantharides can be seen in osmic acid preparations.

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[1] Article Cholera, in Eulenburg's Real-Encyclopädie.

[2] Article Infections-Krankheiten in Virchow's Handbuch der speciellen Pathologie und Therapie. Erlangen, 1864.

[3] Dictionnaire encyclopédique des sciences medicales. Paris, 1874.

[4] Article on cholera in Ziemssen's Cyclopædia. New York, 1874.

[5] Le Progrès Médical, January 10 and February 14, 1885.

Straus did not find fatty degeneration of the epithelium of the convoluted tubules as described by Reinhardt, L. Meyer, Bartels, and others. The granular dust to which the cellular protoplasm is reduced seems to be in part, at least, of hematic nature, as is evidenced by the reddish color which it assumes with eocene, and the greenish brown hue which picro-carminate of ammonia causes it to take. A similar hematic infiltration of the kidney has been seen in various infectious diseases, by Kelsch and Kiéner in malaria, by Renaut in typhoid fever, and by Brault in diphtheria.

While these changes have been taking place in the protoplasmic substance the nucleus still remains visible. But it is shifted toward the basal portion of the cell and, while retaining its circular form, appears swollen and as if pitted with little holes. Those coloring agents which have an affinity for the nuclei, stain it indeed, but less deeply than normal; the aniline colors stain it quite distinctly, while Ranvier's picro-carminate of ammonia does so but feebly.

In certain parts, where the lesions are most pronounced, some of the secreting cells are seen to be converted into a granular mass without any apparent nuclei, but the portions in which such changes are visible are isolated and involve only a small number of the tubules. These nuclear lesions are insisted upon by the writer as of no slight importance. In the straight tubules of the medullary portion these alterations are much less marked; the cylindrical cells present an even contour, with normal nuclei which receive a bright staining. One remarkable fact is that neither in the convoluted nor in the straight tubules are any hyaline, or colloid, casts met with.

The capillaries between the tubules are seen to be enormously distended, and in certain places, though very rarely, red blood-corpuscles are seen within the lumen of the convoluted tubes. The interlobular spaces are also frequently distended by an amorphous or very finely granular mass, colored a pale gray by osmic acid, collected in sorts of splashes. This is an albuminous exudation between the tubules due to an acute œdema of the cholera kidney, and analogous to the acute inflammatory œdema described by Renaut as occurring in certain forms of infectious nephritis. But Straus insists that in cholera there is not, properly speaking, an inflammatory œdema, since the interstitial albuminous exudation never contains leucocytes. There is not, he claims, in the cholera kidney any infiltration of the connective tissue interstices with leucocytes. This was also asserted by Kelsch in 1874.

In the Malpighian bodies there is a partial desquamation of the endothelial lining of the capsule, and where it remains in place it is visibly altered and the cell presents a projecting nucleus. The capillary tufts appear increased in number and the glomerular capillaries themselves are filled with red blood-globules. Within the capsule and surrounding the glomerulus there is frequently an exudation of coagulated albumen, identical with that seen in the spaces between the tubules, and like it also never containing any leucocytes. Rarely the exudation contains some red blood-globules. In a certain number of the larger and medium-sized tubes of the pyramids there is a complete loss of the epithelium, as if it had been brushed away; and in other tubes the lumen is filled up completely with a homogeneous mass, colored gray by osmic acid, which is nothing else than coagulated albumen. These albuminous molds fit closely against the walls of the tubules, showing that the epithelium had fallen off during life and had not been torn away by the manipulations used in preparing the specimen. In some of the tubes the epithelium is still present but is raised up by an albuminous exudation between it and the tube wall. In other parts the epithelial lining is in place, but the cells seem flattened and depressed to the level of the nucleus, which remains prominent and surrounded by a very thin layer of protoplasm. In sections made parallel with the straight tubes the epithelial débris can be seen as casts, and sometimes in the larger tubes twisted into corkscrew shapes by the action of the urine forcing them along. In carefully made sections the straight vessels of the pyramid are seen to be filled with blood, as if artificially injected. They are grouped in bundles alternating with the bundles of the urinary tubules. Certain of the latter are also filled with red blood-globules. This transudation of blood which occurs so exceptionally in the convoluted tubules, is very common and very marked in the pyramids.

In individuals who have succumbed at a later period, during the stage of typhoid reaction, the lesions are of the same sort but more pronounced. The Malpighian bodies have lost a great part of their endothelial lining, and there is frequently within the capsule a granular exudation, dotted with points stained a deep black by osmic acid (fat), and containing a certain number of nuclei. The alterations in the convoluted tubules are very marked; the striated epithelium is, in places, almost wholly destroyed, and nothing is found but the nuclei of the cells, more or less deformed or vesicular. The lumen of the tubule is greatly dilated and filled with granular and fatty detritus, and here and there are great splashes of fat colored an inky black by osmic acid. In certain places the epithelium of the convoluted tubules is less altered and the cells have preserved their form indistinctly, some of the latter containing no nuclei. The straight tubules are also altered in the manner before described, but in greater degree.

A study of these renal lesions described by Straus shows that they may be regarded as quite typical of infectious nephritis, so called by Bouchard. Formerly the kidney lesions found in cholera were almost universally thought to be inflammatory in their nature. Reinhardt and Frerichs called it a croupous nephritis, and according to Virchow it was a catarrhal nephritis beginning in the calices and thence passing gradually upward to the convoluted tubules, and sometimes becoming croupous by reason of a fibrinous exudation. Rosenstein, Lécorché and Bartels are all agreed in admitting the inflammatory nature of the process, and class the fundamental lesion of the kidney in cholera as one of the forms of parenchymatous nephritis. L. Meyer, however, regarded it as merely a passive regressive alteration in the kidney due to venous stasis.[1]

In a memoir published in 1874, M. Kelsch[2] advanced a different opinion.

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[1] Beiträge zur Pathologie des Cholera-Typhoids. Virchow's Archiv, Bd. vi., p. 471.

[2] Revue critique et anatomo-pathologique sur la maladie de Bright. Archives de Physiologie, 1874, p. 748.

He maintained that there was neither a catarrhal inflammation, nor a croupous process, nor even a parenchymatous nephritis. The epithelial alterations were purely of a regressive nature and due clearly to arterial ischæmia. Indeed, he said, the retardation of the circulation was so marked that the relation of cause to effect (*i.e.*, the ischæmia to the death of the epithelium), was easily established and unmistakable. He agreed with L. Meyer in believing the renal alterations to be of a regressive nature, but he differed from him in assuming the cause to be arterial ischæmia rather than venous stasis. The researches of Straus are confirmatory of Kelsch's views.

But before examining these it is necessary to say a few words concerning the experiments of Weigert[1] upon what is known as coagulation-necrosis. This process is defined as a special alteration of the cellular elements, consisting, on the one hand, of a sort of fibrinous transformation of a coagulation of the protoplasmic substance, and on the other, of a rapid disappearance of the cell nucleus, which becomes incapable of being stained by those very coloring materials which possess a special affinity for nuclei.

This necrosis with coagulation may be determined by various causes, of a zymotic nature (in croup, for example), or of a physico-chemical one, or by vascular troubles, and especially by arterial ischæmia. As regards the last mentioned condition, Weigert has shown that when it is complete and permanent, it produces necrosis, pure and simple, with its well-known histological features. But in order that this special form, called coagulation-necrosis, should be produced, it is necessary that the anatomical elements after having been touched by death, should continue to be bathed and traversed by a certain amount of lymphatic fluid. In other words, it is necessary that the ischæmia should be only temporary, and should be followed by the reëstablishment of a nearly normal circulation. Coagulation-necrosis is thus a result of transitory disturbances of the arterial circulation.

As regards the pathological anatomy of the kidney in particular, the researches of Litten[2] throw considerable light upon coagulation-necrosis. He placed a ligature upon the renal artery in rabbits, removing it after two or three hours; then at the end of thirty-six to forty-eight hours the animals were killed, and the kidneys were found to be the seat of the lesions just described as those of coagulation-necrosis. Now the mechanical conditions in respect to the renal circulation in cholera are very similar to those induced artificially by Litten. During the algid stage the arterial pressure is reduced to a minimum, and the kidneys feel the effects of this diminished pressure as well as the other organs. But later, during the period of reaction or of incomplete attempts toward reaction, the renal circulation is reëstablished, as is evidenced by a renewal of urinary secretion. Thus, theoretically at least, the kidney in cholera is in a condition of temporary arterial ischæmia followed by a return of the circulation. Cohnheim speaks of this resemblance to the circulatory disturbances which experimentally produce coagulation-necrosis, and he suggests that it may be the cause of a like change in cholera. But he was unable to confirm this suggestion, owing to the lack of pathological material in the absence of a cholera epidemic.

Straus made his examinations of the renal lesions with this idea in mind, and he states that, while the lesions are of a regressive nature, necrobiotic in their essence, approaching in several particulars to what is known as coagulation-necrosis, they nevertheless do not realize a perfect type of this condition. The protoplasm of the epithelial cells does, indeed, undergo a proteinous degeneration, but it is not, he says, converted into anything resembling fibrous tissue, such as occurs in white infarction of the kidney, induced experimentally. And on the other hand, the cell nuclei are still capable of being stained, although feebly, by coloring materials, which is not the case in typical coagulation-necrosis. Thus, he says, the process approaches coagulation-necrosis but does not fully realize its true type, and it would be forcing facts to conform to theories to maintain the absolute identity of the two conditions. But, the writer adds, it is certainly established that the renal lesion in cholera is of a manifestly passive, necrotic nature, and that there is no infectious disease which determines mortification and desquamation of the renal epithelium with such intensity, and especially with such rapidity, as does cholera.

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[1] Ueber die pathologischen Gerinnungsvorgänge. Virchow's Archiv, 1880, p. 103.

[2] Untersuchungen über den hemorrhag. Infarct. Zeitschrift für Klin. Med., 1879, p. 131, and Virchow's Archiv, 1881, p. 508.

As to the part played by temporary arterial ischæmia in the production of these lesions, M. Straus ventures no definite opinion, and says that though the theory is a very seductive one, it must be acceptedwith caution. For the renal circulation in the collapse of cholera is never so completely abolished as it is in arterial embolism, or by the application of a ligature to the renal artery. This partial ischæmia may assist in the production of these alterations, but the essential cause, he thinks, is to be found in blood changes, of whatever kind they may be. For the kidney lesions of cholera do not differ materially in their nature from those occurring in the course of other infectious diseases, in which blood changes are present but in which there is no question of arterial ischæmia.

In this connection we may also allude to the fact that MM. Ceci and Klebs have recently published a note concerning their investigations on cholera made at Genoa,[1] in which they describe renal lesions very like those found by Straus. They believe, however, that the alteration of the epithelial cells is actually a coagulation-necrosis, and they state that the cell nuclei were either not stained at all, or only very slightly, by gentian violet. Straus, it will be remembered, was never able to discover so profound a lesion of the nuclei as this implies.

The *renal pelvis, calyces and ureters* are generally found congested, with the mucous membrane in a condition of catarrhal swelling. A creamy coating, composed of pus and desquamated epithelium, is a frequent occurrence.

The Bladder may be found empty, as in death during the stage of collapse. More frequently, however, it contains some light-colored, turbid urine, with an abundance of flocculi, composed of mucus, pus and detached epithelial cells. At times the moderate hyperæmic swelling of the mucous membrane, which is rarely absent, may be observed to have become intensified, and dirty patches, resembling diphtheritic membrane, are then found scattered over its surface.

The Female Genital Organs are often found normal. In several epidemics, however, marked congestion of the uterine mucous membrane was the rule. This condition was seen as well in women after the menopause as in the younger ones. Bloody extravasations and diphtheritic coatings were, however, only rarely seen.

The ovaries and vagina, as a rule, participate in the hyperæmic condition of the uterus. And when that organ is normal they, too, have a healthy appearance

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[1] Semaine Médicale, No. 49, 1884.

The Heart.—The pericardium is found moist; the sac often contains some fluid, though never much. Subpericardial ecchymosis is quite rare. The heart still shows more blood on the right than the left side. The fluidity of the blood has generally returned, and its dark color has almost disappeared. In exceptional cases it remains rather thickish. Fibrinous clots are often found deposited upon the valves and may be entangled in the tendinous cords and trabeculæ. Endocarditis is rare. Briquet and Mignot in meeting with several cases have certainly had an exceptional experience. A supposed *endarteritis* has been several times described, but its presence seems to have been inferred from clinical evidence rather than post-mortem findings. Laveran records some French observations where the occurrence of gangrene led to the assumption of existing endarteritis. Still, it is true that, in one instance, an autopsy fully confirmed the diagnosis of such a condition. This case is described by Dr. Laugier,[1] and concerned a man who, during the stage of reaction, developed gangrene of the foot. A firmly adherent clot was found post-mortem in the peroneal artery, and the presence of endarteritis could not be questioned. According to Laveran, *cholera gangrene* could result either from embolism, as just described, or it may be brought about by the general condition of the patient. The finding of heart-clots of presumably ante-mortem formation lends considerable probability to the former assumption. But as to the latter, it appears doubtful whethert he temporary glycosuria (Gubler) now and then observed during reaction has anything to do with the formation of the multiple gangrenous phlegmons observed by a number of writers. This view must be maintained in spite of Mouchet's observations, which no doubt show a marked similarity between diabetic and choleraic gangrene. But this resemblance only demonstrates that a vitiated constitution favors tissue-necrosis, which is an essentially local process.

The muscular substance of the heart looks paler, and it has a more flabby and softer feel than in death from collapse. But fatty degeneration of the fibers has not been discovered, although repeatedly searched for.

The Lungs.—Collapse of the lungs, which, it will be remembered, is singularly well-marked in death during the algid stage, is not seen after reaction. Even the upper and anterior portions of these organs contain plenty of thinly fluid blood. Often, indeed, there is a general pulmonary hyperæmia; hypostatic congestion is, as a rule, quite pronounced; œdema is rarely absent; hemorrhagic infarctions happen rather frequently.

Lobular infiltrations, of a catarrhal kind, greatly exceed in point of frequency the lobar consolidations. Nevertheless, the latter variety of inflammation has been repeatedly observed. The dead-house shows that the lobular pneumonia and capillary bronchitis of cholera does not readily lead to resolution. Reinhardt and Leubuscher describe the presence of cavities filled with a purulent fluid.

Pulmonary gangrene is occasionally found, but it is by no means as frequent a result as one would expect to encounter from *a priori* considerations. In five hundred and forty cases of cholera observed in the service of Horteloup it occurred only a single time.

The condition of the *pleura* is like that of the other serous membranes.

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[1] De la gangrène dans la choléra. Gazette des hôpitaux, 1866.

[2] Des affections secondaires du choléra. Thèse de Paris, 1867

Subpleural ecchymoses occur, but they are exceptional findings. Evidence of localized pleuritic effusion is not infrequently obtained. At times purulent pseudo-membranes may be seen coating the visceral and parietal layers of the pleura.

The Brain and its Membranes.—An examination of the meninges of the brain shows a normal dura, serous effusion with more or less congestion of the pia, and generally a watery transudation into the sac of the arachnoid. It may be mentioned in this connection, that there is little or no hyperæmia of the diploë, a sharp contrast to what is the rule in death during collapse. Meningeal ecchymosis is not infrequent. The dural sinuses are not clogged with blood. The pia sometimes adheres in circumscribed areas to the substance of the brain. Products of inflammatory action are but rarely found deposited upon the membranes. Briquet and Mignot only saw such a condition once in thirty-seven autopsical examinations.

The encephalon is normally moist or shows an excessive serous imbibition. There is an increased amount of cerebro-spinal fluid. The latter contains, according to Voit, a considerable proportion of urea. This also applies to the substance of the brain, the amount of urea being greatly in excess of that found in collapse. Schmidt discovered decomposed urea (carbonate of ammonia) in the cerebro-spinal fluid; Lehmann, however, like Voit, reports only the presence of urea. It is quite noteworthy that both the white and gray matter are always found congested whenever cerebral symptoms were well-marked during the life-time of the patient. Bloody suffusions and small hemorrhages are also recorded. Apoplexy has been observed by Lévy,[1] Mouchet, Tholozan, and others.

Softening of the brain is rare. Potain[2] has recorded two instances of this kind. In both cases the patients had convulsive symptoms. Décore[3] found minute ecchymoses on the floor of the fourth ventricle in the case of a woman, who developed tetanus in the course of an attack of cholera. While it is usual to find the cerebral lesions in correspondence with the brain symptoms during life, cases have been observed[4] where apparently meningitic phenomena occurred without the discovery of the slightest encephalic change. Schneller[5] describes marked hyperæmia of the retina as a common condition in cholera. He says that the retina closely hugs the choroid, except where slight hemorrhages have produced a separation of the two membranes. Other observers failed to discover retinal congestion.

The Spinal Cord and its Meninges require no separate description, as their post-mortem appearance corresponds in all respects with the morbid changes observed in the brain and its coverings, as described as above.

Conclusion.—From the descriptions given in the foregoing, it appears that the microscopical examination of the various organs after death from cholera has not thrown very much light on the nature of the disease, unless we make exception in favor of some of the most recent researches. In a general way it may be said that there occur in cholera widespread parenchymatous changes varying considerably in the degree of their intensity.

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[1] Gazette des hôpitaux, 1848.

[2] Bulletin et mem. de la Soc. méd. des hôpitaux de Paris, 1867.

[3] Thèse de Paris, 1866.

[4] Einiges ueber die Cholera Epidemie, etc. Deutsche Klinik. 1856.

[5] Etats méningitiques dans le choléra. Gazette des hôpitaux. March, 1866.

Cloudy swelling, coagulation-necrosis, granulo-fatty degeneration, hæmorrhagic and necrotic disintegration of cells and tissues are the leading types of the pathological changes encountered. In all cases, circulatory disturbances—an alternation between anemia and congestion, then stasis, extravasation, and the like—precede or accompany the tissue-changes mentioned above. Such processes being frequently observed in many other diseases fail to characterize cholera as the affection *sui generis* which it undoubtedly is. To explain satisfactorily its true nature we are, therefore, compelled to look beyond the tissue changes discoverable after death. But if we invoke the aid of specific micro-organisms of virulent toxæmic properties, the parenchymatous degenerations just mentioned acquire a new significance. They may then be interpreted as specific infectious processes, that are anatomically indistinguishable from similar metamorphoses occurring in other diseases. Hence, far from antagonizing the doctrine of Koch, the pathological histology of cholera furnishes a strong additional argument in favor of its truth. The rapidity with which the organs and tissues of the body become morbidly altered is more easily understood by assuming the parasitic origin of cholera in Koch's sense than by any theory yet announced.

PART FIFTH.

DIAGNOSIS, DIFFERENTIAL DIAGNOSIS AND PROGNOSIS OF CHOLERA.

THE METHODS OF BACTERIOSCOPY AND THE PREPARATION OF PURE CULTURES.

BY

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CHAPTER XXXV.

DIAGNOSIS AND DIFFERENTIAL DIAGNOSIS.

During the prevalence of an epidemic of cholera, the physician will experience no difficulty in recognizing a decided attack of the disease. At such a time it is only the atypical cases, and perhaps the earlier period of typical ones, that may puzzle him. Where a doubt exists, prudence suggests that the benefit of the same be given to the patient. In other words, suspicious cases have been, and should be classed and treated as instances of the real disease. But before Asiatic cholera has been recognized to exist in a given locality, there will be much more difficulty in pronouncing positive judgment upon a given case. And yet it is precisely at such a time, and more particularly during that period of anxious uncertainty and apprehensiveness, when the disease is still spreading in countries or states in active commercial and personal intercourse with the one not yet invaded, it is at such a period that the gravest responsibility rests with him who is called upon to decide the true nature of a suspicious case.

For errors in diagnosis may signify little after the first ravages of the disease have already spread dismay, consternation and panic among the ignorant populace. But an error in diagnosis may signify everything when the disease is not actually with us.

Everybody at all familiar with modern metropolitan life, must know how readily false rumors may spread and grow, creating mischievous panics in their course. Especially among the illiterate foreigners that are herded together in various quarters of our large towns, much needless havoc could be created by premature or unfounded reports announcing the occurrence of cholera. Concealment or suppression of the truth, where intelligent persons or communities are concerned, is never advisable. It is to be supposed that through the daily press and other channels of information the possibility of a cholera visitation is duly recognized long before its actual appearance. Hence the educated portion of the public will be less apt to start a panic from the senseless exaggeration of perils that, faced with calm judgment, may be kept in check.

But it is different with the ignorant, prejudiced, or even half-instructed. To them the mere mention of the word "cholera" suggests all that is terrible, mysterious, and deadly in a wicked and hateful pestilence. And among the bigoted there are those who, even to-day, invest the disease with all the fearful personality and sinister power that belongs to the devil they believe in. If, therefore, it be considered expedient to call all suspicious cases, occurring during an epidemic outbreak, instance of genuine cholera, it certainly seems "good policy," before that time, to exercise extreme caution about the positive expression of opinion. So that even when our own judgment regarding a given case is quite made up, it may be well to avoid its premature announcement. Under such circumstances, wherever practicable, a consultation with others should be had. But even during the period of uncertainty, the necessary precautionary measures may be instituted. And this can be done in so quiet a way that needless fear and excitement will be wholly avoided.

Regarding the actual recognition of Asiatic cholera, we must remember that characteristic phenomena of an attack do not belong to its early period. At that time certain symptoms may be construed as premonitory signs, but since recovery may occur at any moment it would be wrong to announce a positive diagnosis. These early signs consist mainly in a more or less watery diarrhœa, tinnitus aurium, associated perhaps with nervous trembling or even vertigo, mild colicky pains, more or less nausea, a small and rapid pulse, and a tendency to peripheral coldness. The cool and pale tongue, some burning sensation at the epigastrium, perhaps a little griping, complete a picture which is certainly not suggestive of the gravity the case may assume a little later on. In all probability those cases that end in rapid recovery actually represent very slight degrees of choleraic infection. But unless the modern methods of bacterial examination are accepted as giving absolutely reliable results, we have no means of reaching a positive diagnosis of cholera in this the incipient stage. If during the prevalence of an epidemic such cases are generally set down as instances of the disease, we have, nevertheless, no right to say that they have been proved to be such. Even if subsequent events bear out the truth of our assumption, its arbitrary nature must be apparent to all before the sequel has furnished the needed demonstration.

Precisely similar symptoms, during the absence of an epidemic, would invariably be assumed to merely indicate the presence of simple cholera.

It seems to the editor that in this direction the chief practical significance of Koch's researches is to be found. If modern bacterioscopy will give us the means of deciding positively, in a given case, whether we are dealing with a non-contagious disease like cholera morbus, or with a malignant affection like the Asiatic variety, we should eagerly welcome this new method of conducting scientific inquiries.

In the chapters on Etiology the details of Koch's researches will be found, together with the reasons for and against the acceptance of his doctrine concerning the causation of cholera. But it has been deemed expedient to devote a separate chapter to the methods of bacterioscopy, especially as applied to diagnosis, and this will be found at the end of the present part of the volume. Disregarding for the moment the modern bacterial aspect of the subject, let us next turn our attention to the stage of fully developed activity of an attack of cholera. Here we are confronted with difficulties that seem slight as compared with those previously encountered. They may nevertheless constitute an effectual barrier to positive differential recognition.

Many writers draw so vivid a picture of a rarely-missing group of characteristic symptoms, that the veriest tyro should at a glance be able to say: "This is a case of Asiatic cholera."

As a matter of fact, however, the strongly marked features that make quick differential recognition easy, are often observed only so near the end of a fatal attack that the announcement of death may be almost simultaneous with the establishment of a positive diagnosis.

Suppose we have vomiting and purging, a livid hue appearing first at the periphery then spreading over the body and deepening to marked cyanosis, a feeble, filiform, fading pulse, even visible emaciation, characterized by sinking of the eyes into their orbits, hollow cheeks, and empty temples; let there be violent muscular cramps, a cold skin and cool breath, a husky voice, a constant craving for drink with extreme exhaustion; finally even allow the stools to resemble rice-water, and we are yet compelled to state that every single symptom and all combined may occur in violent cholera morbus, where no specific infection has taken place, and where in consequence there is no fear of spreading contagion. It would be folly to attempt to disguise the fact that simple cholera may assume this grave type and even end in death. Cases of this kind are frequently responsible for the rumor that Asiatic cholera has invaded a place. It is only the sequel, *i.e.*, the absence of spreading infection, that permits a real diagnosis.

As the subject of pseudo-Asiatic cholera is both interesting and instructive, it will not be amiss to select a few typical cases at random, from the large number that have been from time to time observed. The cases are all recent ones, and some of them have not hitherto appeared in print.

CASE 1. *Rapidly Fatal Sporadic Cholera.*—The following case was observed by Drs. J. G. Johnson and Jewett of Brooklyn, on July 9th, 1874. The patient, Mary Ann Harrison, 64 years of age, well preserved and temperate, was seized suddenly about midnight with purging, vomiting and most violent cramps in the back, sides and calves of the legs. The countenance was pinched, the skin of the hands shriveled, and the breath was cold. Rice-water discharges followed each other in rapid succession, the vomiting was frequent and increased the pain and distress. The patient was perfectly rational in the intervals of freedom from pain, and was able to give an account of the beginning of the attack. The following morning there was a slight effort at reaction, but the patient sank steadily and died in collapse within 24 hours after the beginning of the seizure. A catheter introduced shortly before death failed to detect any urine in the bladder. The circumstances attending the appearance of this case are thus described by Dr. Johnson:

A man named Callahan had purchased a cargo of damaged fire-crackers and had stored 350 boxes in the room adjoining that which Mrs. Harrison occupied. These crackers had been on a three-months voyage from China in a leaky ship and had become thoroughly soaked with the leakage and the bilge water. The room had a southern exposure, and the hot broiling sun had produced such a decomposition of this immense mass of vegetable matter that the boxes had dropped apart, even the wood of them being rotten, and the paper of the boxes and of the fire-crackers being reduced to a rotten pulp. This room communicated with the room Mrs. Harrison occupied by folding doors (parlors); these from the settling of the house did not completely close, but left a crack of about an inch, through which all this miasm from heat, moisture and decomposing vegetable matter escaped into Mrs. Harrison's room. Her bed was against the doors on the other side. As if this was not enough, the man had placed on the roof of the extension in the hot sun masses of these crackers taken out of the boxes, and a thunder-storm coming up after they had been thoroughly wetted, they were put back into this room for the sun of a July day to dry them, and no means of escape for the effluvia except into Mrs. Harrison's room. Other times wet crackers were placed upon the roof to dry, and the stench was so great that the family up-stairs swept them off on the ground, when they were left to the alternate moisture of the rains and the heat of the sun, till this mushy pulp would feel under your feet like soft brewer's grains.

CASE 2. *Aggravated Cholera Morbus simulating Cholera Asiatica.*—The following is a brief account of a case occurring in the practice of Dr. E. C. Harwood, of New York, in the summer of 1877, and which he reported to the authorities as one of Asiatic cholera. Peter Van K., aged 51, a letter carrier, had always been healthy, with the exception of occasional slight bilious attacks. On July 13th he felt rather poorly and expected one of his usual attacks, but the following day was apparently as well as ever. The next day, which was Sunday, he was in excellent spirits and took a drive with his wife in the morning, but had no appetite for his dinner and complained of feeling poorly all the afternoon. On Monday afternoon he was seized with vomiting and purging with cramps in the abdomen.

When seen a few hours later he was sitting on a sofa, very pale, with a pinched and anxious expression on his face; the eyes were sunken, the pulse was quick and feeble, and the skin cool. After prescribing for the patient Dr. Harwood left, intending to return a few hours later, but was soon called again. At this time the man was very restless, the face was more pinched, and the skin, especially of the hands, was pale and covered with a cold clammy perspiration, and presented the characteristic "washerwoman's appearance." The prostration was marked, the breath was cool, the voice was husky, there were cramps in the flexor muscles of the legs, the pulse was quick and very feeble, and the temperature slightly subnormal. There were frequent rice-water discharges from the bowels. The patient died early the following morning, less than twenty-four hours after the beginning of the attack. Some time after death, on moving the body unmistakable contractions took place in the arm and fingers, and a thermometer placed in the axilla registered 103° F.

The certificate of death from collapse induced by cholera, was refused by the Board of Health, and the case was put into the coroner's hands. At the autopsy, made thirty-two hours after death, the stomach was found to contain about half a pint of watery fluid of the color of oatmeal. The mucous membrane was pinkish and injected in spots, eroded and could be easily stripped off. The small intestines contained the same sort of fluid. There was no marked projection of either the solitary or agminated glands, and the mucous membrane was pale with here and there little points of congestion. The coroner gave a certificate of aggravated cholera morbus.

CASE 3. *Sporadic Cholera.*—Dr. Tripp, in the Louisville Medical News, December 27, 1884, reports the following cases occurring in the practice of Dr. Pennebaker: Mr. A. K., aged fifty, single, farmer, well developed and nourished, previous health good, was suddenly attacked on the afternoon of August 30th, about four o'clock P.M., with vomiting and purging. He had been in his usual health up to that time. There was no prodromic diarrhœa or nausea. The purging and vomiting recurred at intervals of ten or fifteen minutes for about two hours, when he became wholly unconscious. The stools were preceded by little or no pain, and emesis by no nausea. When I called the patient was comatose, and in collapse. Pulse not perceptible; skin cold, clammy, and of a color resembling the "bluish, leaden-hued skin of epileptics after the long-continued use of nitrate of silver." The pupils were dilated and the respirations were not perceptible.

As he had been in this extreme condition but a short time, artificial respiration was applied at once. The bowels moved spontaneously. The stools were odorless, watery, and contained the "rice-grain" deposit. Respiration showed a tendency to return. Morphine sulph. was given by mouth, and hot applications made to the extremities and abdomen. Respiration was resumed without further assistance in a few minutes. The patient vomited the morphine, and more was given hypodermically. Consciousness returning, severe cramps in the muscles of the calves were complained of.

As soon as the patient had revived sufficiently to know those around him, the purging again induced the condition of collapse, making artificial respiration once more necessary. Morphine was given under the skin. He became conscious, and in the course of an hour the purging ceased. I ordered an enema of one drachm tincture of opium in starch-water, repeated every two hours until four o'clock A.M., when the bowels were checked. The pulse was weak, slow, and irregular, and the mental faculties sluggish. The thirst was intense. The patient vomited several times. Ordered

Quiniæ sulph.	ʒ i.
Acid. sulph. aromat.	ʒ iv.
Syrupi	āā ℥ j.
Aquæ dest.	

M. Sig.: One drachm every two hours, alternated with pepsin gr. v.

August 31st, P.M., the pulse was about one hundred, and weak, the skin inactive and cold. The kidneys acted for the first time at noon, but the secretion was scanty. The patient complained of lumbar pain.

Convalescence was slow but not characterized by the typhoid conditions which so often follows reaction. Dr. Tripp makes the following comments on this case:

The clinical history presents all of the symptoms of a so-called fulminant case of true cholera. The first thing noticed is an absence of all prodromal symptoms which in the majority of cases occur; next, the early appearance of the algid stage, which naturally would appear at an earlier period with prodromic symptoms absent. In this condition the patient was to all appearances moribund, the respirations and pulse being imperceptible, and the resort to artificial respiration would seem to have been the only thing that could coax the ebbing tide of life back again. It is to be regretted that the thermal range was not taken, both during the stage of collapse and after reaction had set in. As far as could be discovered without the thermometer, the fever during reaction did not run very high, or continue longer than a day or two. The muscular cramps in the extremities and suppression of urine were marked features. The urine was not tested for albumen. Absence of uremic symptoms, and also of the typhoid condition during convalesence, would appear rather exceptional when we take into account the gravity of the case. However, recovery was slow, with considerable gastro-intestinal irritation.

CASE 4. *Choleraic Diarrhœa.*—Under this heading Alex. W. Stirling, M. B., of Stapleton, Cumberland, records in a recent issue of the British Medical Journal, the following case:

On the forenoon of July 22d, I was sent for to visit Mrs. C. She had been a woman of fair health and of a ruddy complexion. She was in her sixty-fifth year. She had been suddenly seized, the previous evening, by cramps in the back of the legs and thighs, and in the abdomen, and by severe vomiting and diarrhœa, for which her friends had administered a dose of castor-oil. These symptoms had grown gradually worse, and when I saw her her face was pale and anxious and her skin cold and damp. The temperature in the axilla was 98°; pulse 120, regular, but very weak. The cramps recurred every ten minutes, beginning in the legs, and extending upward to the abdomen, and then followed immediately purging and vomiting. So irritable was the stomach, that she had been unable to retain any food since the previous night; and there was no means of quenching her extreme thirst, for even a mouthful of water was returned at once. Small quantities of brandy and water, brandy and milk, and milk and lime-water, were tried without avail. Chlorodyne was given, but it also was vomited. Mustard was applied to the legs and abdomen, but to little purpose, as I found when I returned later. Subcutaneous injections of stimulants now for a time somewhat restored the pulse; but the improvement was short, and ere long it had become nearly imperceptible at the wrist. In the evening she was still unable to retain anything in the stomach, and remained so till the end. One-sixth of a grain of morphia given hypodermically had relieved the cramp to some extent; but, in spite of the free use of stimulants, she became gradually weaker, the voice became husky, and at midnight she was in a state of collapse, the vomiting and purging ceasing as this grew more marked, till they completely stopped unless anything were taken to relieve the thirst. The temperature was always subnormal. I did not see the vomited matter or stools at midday; but in the afternoon and evening the latter were of a character corresponding exactly with the descriptions given of those of Asiatic cholera. The fluid contained no bile, but was clear, thin, and watery, and had no fæcal look or smell, but contained rice-like bodies in suspension. The vomited matter varied with the amount of liquid swallowed, being sometimes clear and watery, or stained slightly green, or glairy and containing more mucus, but I saw no flocculi in it. She had passed no water since Monday evening; and at one o'clock on Wednesday morning there was no sign above the pubes of water in the bladder; but to make sure I passed a catheter. I found it absolutely empty. The collapse became more profound; and in the early morning she died, having remained sensible to the last.

Five days later, her son consulted me on account of watery diarrhœa and cramps in the legs; but lead and opium pills relieved him, and he was well in a couple of days.

In his remarks on this case the author says: "How great may be the resemblance of summer cholera to true Asiatic cholera, as exemplified in the above, and to some extent to poisoning by arsenic, is what strikes me as noteworthy in the above case. The idea of the latter I dismissed from my knowledge of the people and their surroundings, as well as from the fact that the vomiting and diarrhœa had not the characters usually seen in such cases, nor was there any pain in the stomach. Had the case occurred in a seaport town, except from the absence of the germ, there might have been difficulty in deciding as to its nature. Dr. Bristowe says, in his "Theory and Practice of Medicine," page 761: 'The symptoms have, in fact, a close resemblance to those of Asiatic cholera, but differ from that clinically in their circumstances; that the evacuations rarely, if ever, assume the rice-water character or are devoid of bile; that the urine is not generally suppressed; and that the collapse is neither so sudden nor so extreme as in the epidemic disease.' In the case of Mrs. C., the rice-water character of the stools was most marked; there was no bile; the urine was completely suppressed, and collapse was present to a considerable degree when first I saw her, and had become as absolute as is consistent with life within twenty-four hours. If we suppose the case to have occurred in a town open to choleraic infection, the illness of the son, though beginning five days after his mother's death, might have been taken as evidence in favor of the contagious character of the disease."

Case 5. *Simple Cholera.*—In the "Annual Report" of the Supervising Surgeon-General of the Marine Hospital Service of the United States, for the fiscal year 1884, we find the following record of a fatal case of simple cholera:

C. W., aged 20 years; nativity, Virginia; was admitted to the marine ward of the Good Samaritan Hospital at Cincinnati, Ohio, July 9, 1883. Died July 12.

History—The patient, a deck-hand from the steamer Will Kyle, was taken sick with diarrhœa several days before he made application for relief. At the time of his admission to the hospital he was suffering from diarrhœa, pain in the back, thighs, and calves of his legs, with temperature of 32.2° C. The next morning his temperature was normal, but rose to 40° C. in the evening. Simultaneous vomiting and purging began about noon and continued during the day and night, accompanied with severe cramping of the muscles of the abdomen, back, thighs, and calves of the legs. The dejections, which were frequent and in great quantity, resembled *purée de pois*, and similar matter was vomited, with the addition of bile. Pulse frequent and feeble. Urine high-colored, free from albumen, and scanty. Respiration frequent; voice trembling and feeble. Distress and anxiety were marked symptoms. July 12, the day he died, epistaxis occurred, and could only be checked by plugging the posterior nares. His temperature fell to 36° C.: algid symptoms, resembling those of malignant cholera, followed; pinched face; icy coldness of the extremities; skin of hands shriveled, and eyes deeply sunken. He became comatose a few hours before death.

Autopsy—Rigor mortis well marked; stomach nearly empty; mucous membrane inflamed and softened to such an extent that the rugæ were hardly visible. The inflammation was general, but did not extend beyond the mucous layer, which was much swollen, and came off with slight pressure of the fingers. The vessels of the small and large intestines were distended, giving these viscera a deep-pink color. They contained considerable excreta, resembling the dejections. Mucous membrane of large and small intestines throughout inflamed, softened, and in places denuded. What few patches of Peyer and solitary glands could be recognized were much swollen. Peritoneum not inflamed. Liver congested; gall-bladder full, and ducts free. Kidneys anæmic but not diseased. Spleen somewhat enlarged. Hypostatic congestion of posterior border of both lungs and hepatization of the base of each. Right side of heart contained a little blood. Blood in heart and arteries about the color and consistence of black molasses. Brain not examined.

Case 6. *Simple Cholera.*—The following is a succinct account of a case of simple cholera of unusual gravity, which occurred recently in the practice of the editor.

Mr. R., æt. 52; German. He was of temperate habits although his occupation of restaurant keeper necessitated a certain amount of irregularity. I was summoned in great haste at 5 A.M. to see him, as he was supposed to be dying. This happened during the heated term in August, 1884.

The patient was found in complete collapse, livid, cold, pulseless, but moaning from pain occasioned by muscular cramps. Vomiting and purging had come on only six or seven hours ago. The discharges had within the past hour assumed a watery consistence, and occurred about once in fifteen minutes. Nothing had been retained by the stomach for several hours, yet vomiting still continued. The poor sufferer looked indeed moribund, yet his intelligence was retained, and in a husky whisper he called constantly for cold drinks. No symptom belonging to the collapse stage of Asiatic cholera seemed wanting.

Hypodermics of camphor dissolved in ether, brandy, and after a while one-third of a grain of morphine were given. Heat, friction, sinapisms, were liberally employed, and to my great surprise and satisfaction the patient rallied inside of two hours. Suffice it to say that he made a rapid and complete recovery. As soon as purging had ceased the rectal temperature was found to be 100.5° F.; the axillary temperature could not be taken on accouut of the restlessness of the patient.

Such cases could be multiplied *ad libitum*. But it seems unnecessary to adduce further isolated evidence in support of the assertion that our ordinary clinical methods are at times insufficient to warrant a differential diagnosis. And that, therefore, it has often been found imperative to "await developments" before giving an absolute and definite opinion whether simple or Asiatic cholera was present.

One of the most recent writers on cholera, Dr. Stillé,[1] has so well appreciated and demonstrated this difficulty, that in view of the intrinsic importance of the subject we here insert a quotation from his article. Speaking of the most characteristic symptoms of Asiatic cholera, he says:

> But every one of those symptoms may occur in cholera morbus produced by a direct irritation of the stomach and bowels. It is rather their nature, we repeat, than their phenomena that distinguishes these two affections from each other. In attempting to separate Asiatic cholera from other forms of cholera we must endeavor to dismiss from the mind the erroneous notion that the term cholera denotes a definite disease identical in its cause, phenomena and results. It is no more a disease than dropsy or fever is a disease. It is a complex group of symptoms which have in common the fact that they proceed directly from the gastro-intestinal irritation, whose degree of severity—*i.e.*, the presence or absence of certain grave symptoms—and, above all, its issue, depend chiefly upon the nature and intensity of the cause of the attack, and also, necessarily, upon the degree of resistance opposed to it by the subjects of the disease. Nothing has led to more error in regard to epidemic cholera than the ignorance of this pathological fact by some and the disregard of it by others.

Further on he writes as follows:

> The Greek, Roman and Arabian conceptions of cholera morbus included a discharge of bile, the very symptom for the absence of which Asiatic cholera is notorious; and also that the classical cholera, or cholera morbus, ended in recovery even more frequently than Asiatic cholera terminates in death. But local epidemics of cholera morbus sometimes take place which are of a severe and even of a grave type, and which also appear to originate in some peculiar atmospheric influence, for they prevail to a limited extent and in connection with vicissitudes of weather. Still more circumscribed epidemics have been traced to unwholesome food and drink, and innumerable instances of individual attacks have been caused by irritants that are ranked as poisons and others which are reckoned as food or medicines.

Macpherson,[2] after a detailed discussion of the subject, says: "Cholera indica is essentially a very fatal disease, while cholera nostras is usually a mild affection and is seldom fatal, although it was called *atrocissimus et peracutus*, and has undoubtedly killed in from eight to twenty-four hours."

Yet he freely admits that there is not a single symptom that is pathognomonic of either disease.

In this place the writer may be allowed to quote from a recent article by himself, published in The Medical Record of November 29th, 1884, which called attention more particularly to the necessity of bacterioscopy for diagnostic purposes:

"It is obvious that the earliest possible recognition of the very first case of cholera that might appear among us would give us the best chance for prompt action to prevent any extension of the disease. Now, it is a lamentable fact that the most careful analysis of symptoms does not always enable us to distinguish, in a given case, cholera morbus from genuine Asiatic cholera. Indeed, it is held by some physicians that the two diseases differ in degree only, and not in kind.

"Without stopping to consider this point, we must yet face the fact that our usual methods are inadequate to differentiate with absolute certainty an attack of violent and fatal cholera morbus from one of true cholera. The kind of reasoning hitherto employed by physicians has necessarily been of the *a posteriori* variety. That is to say, if a suspicious case recovered, and was not soon followed by other and rapidly fatal cases, the disease was classed as cholera morbus. If, on the other hand, the first suspicious case was quickly followed by an increasing number of fatal cases, the diagnosis of Asiatic cholera was subsequently made. Manifestly, a method of this kind might give the cholera a chance to secure a dangerous foothold before being recognized as such; and one need not be an alarmist to entertain grave apprehensions should such a misfortune befall us. But in view of recent discoveries, it now seems possible to decide positively and in a very short time whether we are dealing with the comparatively benign cholera nostras, or with the eminently malignant Asiatic cholera."

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[1] Loc. citat., p. 750.

[2] Medical Times and Gazette, December, 1870, p. 725.

And further, "in scientific bacterioscopy we have quite possibly a ready means of detecting with certainty the existence of cholera." Since the above was written the editor has not had reason to change his views. He still believes that competent persons may be able to decide from microbiological evidence which disease we are dealing with. But of course it is to be admitted that others hold a different opinion, and confidently assert that the various attributes of the comma-bacillus furnish insufficient and utterly unreliable data upon which to base a differential diagnosis. From the same article the following is also taken, as having a bearing on the subject under consideration:

> But in order to familiarize ourselves with the necessary details of these modern methods, earnest study and some experience are essential. I hold that we have not the right to ignore the light that has been shed on the true nature of infectious diseases by the keenly searching spirit of modern experimental inquiry. . . . Let the State Health Boards organize properly equipped laboratories for the purpose of affording suitable facilities for this kind of study and research. Individual physicians with sufficient time and private means should take an active interest in all that relates to the examination and cultivation of bacteria. Is the medical profession of our country to be put to shame by its attitude of apathy toward matters of serious concern to the public welfare? Are we to be made the laughing stock of our transatlantic confrères? Two well-known physicians of our country have already attempted to overthrow the diagnostic significance of the bacillus of tubercular consumption, the one by claiming it to be a fat-crystal, the other by asserting its identity with shreds of fibrin. But neither the one nor the other had at the time of his pretended discovery ever beheld the true bacillus tuberculosis. To avoid similarly ridiculous errors we need expert teachers of bacterioscopy.

And further:

> Koch's conclusions were accepted without hesitation by those who knew him best, and who have had occasion to witness his conscientious and painstaking methods of conducting all scientific work. Thus, in Germany, Herr Von Gossler, Minister of Public Worship, Education, and Medical Affairs, has already ordered that a certain number of medical men are to be summoned to Berlin every year to go through a course of study, lasting from a fortnight to three weeks, in order to learn the new methods of investigation connected with bacteria and micro-organisms, but chiefly to become acquainted with everything connected with the comma-bacillus and the methods of cultivating it according to Koch's method. The several Federal Governments have been likewise officially requested to select a number of medical men for these courses and to inform them to hold themselves in readiness to come to Berlin. In our own country, however, there is still, even in the ranks of the medical profession, an unfortunate disposition to regard the entire subject of bacteria as trivial or fanciful, and unworthy of serious consideration.

And finally, concerning the present status of this kind of investigation it was said:

> That scientific bacteriology is as yet in its infancy all will admit. But let us not blindly ignore its actual accomplishments. We may never be able, perhaps, to completely eradicate consumption or suppress all contagious diseases, but at present we are without the slightest doubt nearer to such a desirable consummation than we were before the era of bacterioscopy.

In this place allusion may also be made to the recent debate upon cholera which took place before the Royal Medical and Chirurgical Society.[1] Mr. Cheyne, who studied the subject during the Paris epidemic of 1884, replying to the contrary assertions of Klein, positively showed that Koch's cholera bacillus, whether comma-shaped or not, possessed unmistakable characteristics, sufficient to separate it from all other known bacteria. It was clearly a distinct species. It is significant that Klein was compelled to acknowledge that the curved mouth-bacilli had to be grown in media different from those of the curved cholera-bacilli, in order to make the respective cultures look alike. This alone is a positive proof of the fact the cholera commas are as distinctly different from the similarly shaped buccal organisms as they are from the Finkler microbe, and the cheese-spirillum of Deneke. But it does not follow from this that Koch's commas must be causative, even if they are clearly diagnostic of Asiatic cholera.

In an editorial article on the above debate, a leading, medical journal[2] remarks that "the establishment of a causal connection between the comma-bacillus and cholera is of far less practical importance than this other achievement, which, it would appear, may now be fairly credited to him, *i.e.* Koch; namely, that he has supplied us with a means of diagnosing Asiatic cholera in the early stage."

So, too, in a critical review of this recent English discussion Dr. Gaffky[3] has shown that the objections of Klein cannot be upheld, and that they have by no means invalidated the conclusions of Koch, especially with regard to the possibility of reaching an early diagnosis, if careful search be made for the cholera-microbe.

But to resume: While we must admit that the most careful scrutiny of clinical phenomena will not always suffice for diagnosis; while, excepting the diarrhœa, every one of the usual signs may be missed, and yet the patient die of cholera, we must nevertheless, emphasize those clinical symptoms that are of decided value in arriving at a correct diagnosis.

The discharge from the bowels constitutes the first symptom, both in point of time and as regards actual importance, that demands attention. Considered alone there is nothing decisive or pathognomonic about this sign.[4]

Yet when copious watery dejections follow an ordinary diarrhœa, or mark the incipience of disease, when they occur with increasing frequency and losing all fecal odor and appearance, assume a rice-water likeness, we may surmise cholera. If a careful history of the patient is taken, resulting in the exclusion of irritant poisoning, and if we have reason to believe that he may have been exposed in some way to infection with Asiatic cholera, even though there has occurred no similar case in the locality where he then is, we may safely say that the case is one of Asiatic cholera. If there is no history of possible infection and the case occurs in a seaboard town, we must nevertheless regard it with grave suspicion. In the smaller inland towns, where communication with other places, states and foreign countries is at a minimum, a case of that kind may be regarded with less suspicion, but should nevertheless be closely watched.

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[1] London Lancet, March 28, 1885.

[2] The British Medical Journal, April 4, 1885.

[3] Deutsche Medicinische Wochenschrift, April 16, 1885, p. 250.

[4] The finding of the comma-bacilli in suspected discharges is purposely left out of consideration in this place; for many may not be willing to accept that kind of evidence as conclusive. And of those who have this willingness, a large proportion may lack the time and training necessary to obtain satisfactory proofs of their specific identity.

Again the abrupt appearance of copious rice-watery discharges, quickly followed by vomiting, collapse, cyanosis and other marked symptoms that need not be repeated here, will justify a diagnosis of cholera Asiatica, especially if the possibility of infection cannot be positively excluded.

Other valuable diagnostic signs may not be ignored. The exceedingly rapid cooling of the surface of the body is certainly quite uncommon in ordinary diarrhœa, or simple cholera morbus. In Asiatic cholera, as we have seen, it is the rule. So, too, the speedy fading away of the pulse, and especially the development of deep cyanosis are exceptional occurrences, even in severe cholera morbus. Another valuable sign is afforded by the quick interference with, or the complete suppression of, various secretions. This is likewise hardly ever seen, to the same extent, in other diseases.

Painful muscular cramps, occurring when there are only mild diarrhœal manifestations, should always put us on our guard. When all these symptoms occur in orderly sequence, as has been fully set forth under symptomatology, they constitute a formidable array of evidence for a safe diagnosis. Should the patient live, the cycle may be made yet more complete by the supervention of those disturbances that have been detailed in describing the period of reaction, and under complications and sequelæ. A simple diarrhœa or an attack of cholera morbus is scarcely ever followed by a train of morbid manifestations that in Asiatic cholera are common events. So that if indecision characterized the physician's judgment at first, it may be replaced by relative certitude later on. A fatal issue need not, therefore, be awaited before a definite opinion is formulated.

There are yet other aids to diagnosis. Simple cholera can generally be traced back to a definite exciting cause, be that some alimentary disturbance, an irritant poison, cold, debauch, or any other agency capable of producing intestinal mischief. The development of the disease is often much slower than in Asiatic cholera, though at times the reverse obtains, and cholera morbus is developed with startling abruptness. No matter how profuse the diarrhœa may be, the evacuations but rarely lose all trace of fecal odor in simple cholera. Again, though it may lose its color completely, yet the characteristic rice-water appearance of the genuine cholera-stool is only exceptionally found.

The vomiting of sporadic cholera generally occurs before purging, the stomach being first to suffer in the vast majority of cases. In Asiatic cholera we have seen that vomiting, as a rule, follows the purging by a definite interval.

Limpid fluid is hardly ever thrown up from the stomach in simple cholera, whereas it is rarely missed in the Asiatic variety. Bloody stools are unknown in cholera morbus; in grave cholera Asiatica they are at least not very infrequent. The flabby, doughy condition of the abdomen with the physical signs of accumulating fluid in the intestines, belongs to

Asiatic, but not to simple cholera. Præcordial oppression, great anxiety, intense dyspnœa are absent in simple, often present in Asiatic cholera.

Cholera morbus may lead to livid collapse, yet the skin rarely assumes the icy coldness and deep purple or blackish hue, observable in epidemic cholera. The marked loss of cutaneous elasticity, resulting in the persistence of pinched-up folds of skin, is part and parcel of the latter but not of the former malady. Complete suppression of urine, which, as has been shown, is quite common in Asiatic, is exceedingly rare in simple cholera, although even in the latter affection the renal secretion is often much reduced in quantity.

From this brief survey of the main points of difference in the symptomatology of simple and epidemic cholera, the reader will infer, what has been repeatedly mentioned before, namely, that in a given case it often requires the utmost circumspection and the careful balancing of probabilities before a correct judgment can be formed. Moreover, that where a clear history is not obtainable, a differential diagnosis based on individual symptoms or groups of symptoms will frequently be impossible.

It remains now to glance at a number of morbid states that have a symptomatology resembling the disease, but in which a painstaking examination will generally dispel the suspicion or supposition of actual cholera Asiatica.

Acute intestinal obstruction, strangulated hernia, the early stage of peritonitis, especially when due to perforation, violent gastric, hepatic or renal colic, may all lead to such serious shock that, during the prevalence of an epidemic, and on superficial examination, they may be and have been regarded as cases of choleraic collapse.

Drasche states that incipient pneumonia, typhoid fever, acute exanthematous diseases, and even acute tuberculosis, have been mistaken for cholera. And he adds that cases of that kind, during the excitement of an epidemic, are everywhere at times erroneously classed as cholera.

So, too, acute intoxication from corrosive substances, as well as arsenical poisoning, have been and may be mistaken for Asiatic cholera. Indeed to the illiterate lower classes their undeniable analogy has repeatedly seemed so striking that disastrous consequences or at least threatening popular disturbances have resulted.

The most frequent charge has been that the wells were poisoned by some criminal. In the recent French, Italian and Spanish epidemic (1884) physicians have likewise been openly charged with poisoning their patients. In several instances reputable doctors have been mobbed on this absurd supposition.

Poisoning by commercial acids, such as nitric and sulphuric acid, and intoxication with corrosive sublimate, resemble to a certain extent the effects of choleraic infection. The stomach being, however, always first to suffer (unless indeed the symptoms indicate disease still higher up), and a clear history being often obtainable, there should generally be little difficulty in differential diagnosis.

Where irritant poison has been swallowed the abdominal pain is, as a rule, intense, constant, and burning. Violent paroxysmal colic may occur, although this is rather exceptional. Still these symptoms do not occur in Asiatic cholera. If there is neither smarting pain nor rawness in the mouth and throat, a disagreeable metallic taste often leads to the recognition of intoxication.

The stools are never as watery and copious in poisoning as in cholera.

On the other hand they are frequently mixed with blood, give forth a fetid odor, and occur with pain followed by tenesmus or smarting in the rectum. The vomit is generally bilious and bloody in corrosive poisoning. Again, although the secretion of urine may be much diminished, it is only exceptionally quite suppressed. Strangury often follows poisoning, or there may be merely vesical tenesmus.

The general appearance of patients suffering from irritant poisoning is likewise different from what is commonly seen in cholera. There is less pinching of the features, the cadaveric hollowness is absent, the voice is not the vox cholerica, and though collapse may be quite as pronounced, cyanosis never attains that pitch of darkness seen in cholera.

Nevertheless, cases of criminal poisoning by arsenic have been repeatedly mistaken for cholera. Thus Flamm records the singular case of a French woman, who in the course of twenty years succeeded in killing over forty victims by practicing her heinous methods during the prevalence of an epidemic.

But the medico-legal aspect of the subject cannot be fully dealt with here. The wary practitioner will do well to closely examine into the history of every supposed cholera case in which vomiting has preceded the diarrhœa.

The accidental ingestion of tainted or putrescent foods, *e.g.*, unwholesome meat or fish, spoiled milk, butter, cheese, preserves, pickles, etc., also decomposing fruits or vegetables, may all lead to symptoms simulating cholera. Latterly poisoning from canned goods, adulterated foods, bad beer and wines have come more or less prominently before the profession. These accidents are merely mentioned in passing, as possibilities that should not be lost sight of. For a full account of them, the reader is referred to the standard treatises on toxicology and medical jurisprudence.

Finally the incautious employment of drastic purgatives may be remembered as liable to give rise to phenomena of vomiting, purging and collapse that would be apt to be erroneously interpreted during the prevalence of cholera. Recently some cases of poisoning through colchicum have also been reported where the symptoms closely resembled an attack of cholera.

As regards dysenteric diseases happening during the prevalence of cholera, the constant presence of blood in the dejections, the more or less persistent tenesmus should suffice to preclude errors in diagnosis.

In intensely malarious districts cases are at times observed that may appear very puzzling to the practitioner, but in the absence of cholera a correct diagnosis is always possible by a careful examination of the patient. In countries, however, where cholera is endemic and malaria is likewise never absent, a diagnosis cannot always be made. In his work on Malaria, Dr. Sternberg[1] gives the following account of the subject;

> The state of collapse into which the victim of an algid pernicious paroxysm quickly falls, resembles very closely the collapse of cholera, but the discharges from the stomach and bowels, which are often quite copious, are commonly bilious in character. A form of pernicious fever, denominated *choleraic*, has, however, been observed, which seems to merit this name from the prominence of the choleraic symptoms, and from the fact that the discharges resemble those of true cholera. But it is questionable whether the *choleraic* pernicious fever of authors is properly ascribed to the action of malaria alone. First, we note that this form is most common in regions where cholera also prevails, and there is reason to believe that the endemic prevalence of malarial fevers and cholera in the same ter-

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[1] Malaria and Malarial Diseases. New York, W. Wood & Co., 1884.

ritorial limits has led to confusion in this case, just as in the case of typhoid fever and malaria, and of yellow fever and malaria, in regions where these diseases are associated.

The choleraic form of pernicious fever has also been observed in localities far removed from the endemic prevalence of Asiatic cholera; but, as Colin remarks, it is especially during the season of greatest heat, when sporadic cases of cholera are also seen, that these cases occur, and this author very properly ascribes the choleraic symptoms to the meteorological and local conditions which produce *cholera nostras*, rather than to the malarial poison *per se*. The fact that the choleraic symptoms are an addition to those induced by the malarial poison is further shown by the non-recurrence of these symptoms during successive paroxysms, contrary to the rule in ordinary algid pernicious fever. The collapse of algid malarial fever differs from that of cholera in the absence of cramps and in the facies of the patient, which in the one case is calm and expressionless, and in other indicates the suffering caused by the characteristic cramps, which are common to both epidemic and sporadic cholera.

The English physicians in India admit that the symptoms of cholera and of malarial poisoning may coexist, and so closely are they often associated that in many cases no distinction is made, and the mixed disease under the general name of fever is ascribed to malaria.

The same writer, quoting Colin,[1] says that:

> In Cochin China, where the French troops suffered severely from cholera, more deaths also occurred from choleraic pernicious fever than from the other forms of pernicious intermittent—algid, etc.—although outside of the range of the choleraic influence, this form is comparatively rare. The same fact was observed at Ancona in 1865, during which year a terrible epidemic of cholera raged in that city. At the moment when the Indian pestilence had almost entirely disappeared, there occurred still every day a certain number of grave attacks, which led to the belief that it was still present. These were pernicious fevers, which are far from being rare at Ancona, but which in this year, under the influence of the choleraic constitution, manifested themselves in this form with unusual frequency. The following year the cholera was at the gates of Civita Vecchia, among the workmen engaged in building a railroad upon the sea-shore, and I remarked here also the augmentation of the number of attacks of "choleraic pernicious fever" in our garrison in this city. It seems then that a special medical constitution favors the explosion of attacks of this kind, whether this constitution be based upon the influence of a cholera epidemic coming from India, or simply upon the elevation of the temperature, which in our country, and especially in England, causes to occur each year some cases of *cholera nostras*.

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[1] Traité des fièvres intermittentes. Paris, 1870.

CHAPTER XXXVI.

PROGNOSIS.

Prognosis during the Attack.—The prognosis in a fully-developed attack of cholera is always grave. At the very best it is uncertain. In the beginning of an attack the visible signs will perhaps incline the physician to take a hopeful view of the case. But a few hours may witness so complete a change in the condition of the patient, that the last remnant of hope will seem dashed to the ground. Still, as has been previously pointed out, the almost miraculous can happen, namely, that a patient apparently moribund may speedily experience a mysterious accession of new vitality that carries him safely through a rapid convalescence into a complete recovery. Unfortunately, however, the latter event is much less frequent than unexpected death. It may be questioned, in view of the admitted uncertainty of prognosis, whether an attempt to formulate rules is at all admissible. In answer it may be stated that, while no disease shows more clearly than epidemic cholera the unreliable nature of human forethought, nevertheless some signs and more particularly certain combinations of signs, afford valuable points upon which a prognosis may be based. But it cannot be too strongly urged that, whatever experience has shown to be the rule, cholera knows no rule that has not its exceptions.

In a general way it can be safely said that the mortality of an epidemic is greatest in the early part of its appearance, and, progressively diminishing, becomes least toward the end. Now it is possible to account in some measure for this peculiarity by supposing that the weakened, cachectic or otherwise predisposed are first attacked and quickest to die. This plausible view of the matter receives support also from the fact that newcomers are as liable to contract the disease in the decline of an epidemic as during its incipience.

Stoufflet,[1] for example, found that among acclimatized Parisians there was a decidedly smaller mortality than among the newly-added population. In fact, the history of all epidemics occurring in cities furnishes similar evidence.

But a completely satisfactory explanation of the high mortality attending the early part of a cholera demonstration is still forthcoming, even if, in addition to what has been stated, we take into account the fact that the cholera microbes form no spores, and have no permanent state.

The manner of development of an attack in the individual case is of considerable prognostic significance. If there is no orderly sequence of symptoms, if the various characteristic phenomena seem to break out simultaneously with the force and suddenness of a great conflagration, then the system is speedily overwhelmed, and a fatal issue is inevitable. If in such cases the first violent shock does not speedily kill, any subsequent reaction is, as a rule, imperfect and temporary, or it assumes the form of a grave typhoid with the prognosis as bad as ever. On the other hand, with a gradual and, so to speak, orderly evolution of morbid phenomena, there is an avoidance of violent shock, and the chances of recovery are much better.

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[1] Le choléra a l'hôpital Lariboisière en 1865. Paris, 1866.

Among the various symptoms of the disease the greatest prornostic significance undoubtedly attaches to the ejections, and of these the alvine evacuations have more importance than the vomiting. The direct influence of the intestinal discharges on the course of the malady has already been noticed. When they are copious, frequent and very thin, a bad prognosis should be given. When they show a tendency in an opposite direction, and especially if they continue to look bile-stained, some hope of a recovery may still be entertained. It is only very rarely seen that the stools partake somewhat of a fecal character in cases that show progressive deterioration until death.

The nearer the stools approach to thin rice-water in consistency, the graver the affection. A somewhat milky appearance augurs better than a purely limpid one. When blood is found to be mixed in appreciable quantities with the dejections, the prognosis is decidedly bad. According to Drasche and other observers, a fetid chocolate-colored discharge signifies inevitable death.

It happens at times that, while intestinal transudation is as violent and copious as ever, the external discharges are abruptly checked. The abdomen in such cases becomes flabby, and succussion reveals the presence of large quantities of liquid. This, with but few exceptions, has been found to constitute a fatal sign.

Again, in place of being retained, the fluid may appear to flow away in a steady stream from the collapsed patient. Incontinence of this kind is also a lethal symptom. When, however, the external discharges become less profuse and occur at longer intervals, especially if they once more look bile-stained, a favorable turn may be expected with great confidence. It is likewise a good sign if, when the discharges have ceased, an examination of the abdomen shows that the intestines are not filling with liquid, but rather with gas.

As regards vomiting, its prognostic significance is slight when compared with purging. Still, if the patient vomits oftener than he purges, we may look for a bad ending. But if moderate vomiting continues, the chances are better than when it abruptly stops, unless there be a simultaneous amelioration of the patient's general condition. Indeed if cessation of vomiting is accompanied by oppression and general restlessness, we are dealing with a very grave if not a fatal sign. When the ejected matters become considerably blood-stained or chocolate-colored, a fatal prognosis is always justifiable.

Lübstorff has made a special study of choleraic vomiting. According to him the symptom occurs within the first twenty-four hours of an attack in 74 per cent. of all cases. When diarrhœa continues without the appearance of vomiting, the chances after a few days are much in favor of the patient. This writer goes so far as to assert that diarrhœa during an epidemic of cholera, if not followed by vomiting in from five days to two weeks, will never lead to cholera, and, therefore, warrants the expression of a favorable prognosis. But the statements of this writer are not in accordance with what other authors have found, and should not be too implicity relied upon. It is much safer to regard every attack of diarrhœa with suspicion during the prevalence of cholera, whether vomiting occurs or not, and to give a favorable prognosis only when it readily responds to treatment.

The varying severity of the disturbances of circulation often affords some clue to the direction in which matters are tending. Steadily increasing feebleness of peripheral pulsation, culminating in complete suppression of the radical pulse, is very ominous. If the larger arteries no longer reveal pulsation, death is almost certain. Other grave symptoms consist in the fading away of the apex beat, and with it the second sound, the occurrence of blowing murmurs, and the development of pericardial friction sounds. Dyspnœa, an icy coldness, and deep cyanosis are rarely wanting to still further indicate the approach of death, when this stage of the disease has been reached.

The return of pulsation after its complete interruption is a favorable sign only when other symptoms of beginning reaction accompany it.

Whenever a rapid and decided sinking of the temperature occurs, we may look for a grave or fatal attack. Gradual reduction of the body-heat denotes a milder and more protracted affection.

Macnamara believes that if the external temperature of the body "does not sink below 95° F., the respiration not rising beyond 25°, or the pulse upward of 100, we may safely conclude that our patient has a very good chance of recovery. Probably 85 per cent. of such cases get well." But "if the temperature of the patient's body rapidly falls to 93° or 94°, and remains at that point, the respiration rising in proportion and the pulse becoming imperceptible, our patient is in extreme danger, the more so as these symptoms have been rapidly induced."

After a patient has once passed into profound collapse, he may be pronounced out of immediate danger only when all the symptoms already described as characterizing that condition have receded. In other words vomiting and purging must stop, pulsation must be reëstablished, cyanosis vanish, warmth return, and breathing become free and easy. A failure in any of these respects indicates the continuance of danger.

Much sweating, except during reaction, is a bad sign. The breaking out of cold, viscid sweat in patches here and there, is more unfavorable than a uniformly distributed or relatively warm perspiration.

The suppression of urine is generally a bad sign. On the other hand even in seemingly hopeless cases, the exceptional continuance of the renal functions may be the one favorable symptom on which the faint possibility of a rally still rests.

Muscular spasms may become grave prognostic signs, not on account of their intensity or painfulness, but because they affect many groups of muscles, and especially when they attack the trunk rather than the extremities. Still, as cramps are not peculiar to cholera, they are of comparatively slight importance in deciding or influencing prognosis.

In regard to manifestations on the part of the nervous system, quietude, indifference, apathy, somnolence, and especially sopor, are always more to be dreaded than restlessness, watchful activity, sleeplessness and even great anxiety.

Prognosis during the Period of Reaction.—In pronounced cholera when the patient has not quickly succumbed to the severity of the disease he is by no means out of danger. It is impossible to foretell from the character of his symptoms during the acuteness of the attack, whether a speedy reaction or a slow one is to follow, whether relapses are not in store for him, and finally whether grave complications may not be followed by equally grave sequelæ.

Oscillations beween natural warmth and previous coldness, the appearance or persistence of viscid sweat, the continuance of intestinal transudation without immediate re-absorption, are all so many evil prognostic signs, even after reaction has been fairly established.

On the other hand, the return of a natural facial expression, the breaking out of a uniformly distributed warm perspiration, the rapid absorption of intestinal fluid, are decidedly favorable signs. The disappearance of nervous manifestations, taken in conjunction with the symptoms just mentioned, is additionally favorable to a good prognosis, since a typhoid exitus is thus rendered improbable.

Concerning the importance of the renal secretion in the period of reaction, enough has been said under Symptomatology to make a further discussion here seem unnecessary. If sufficient healthy urine does not appear soon after reaction is well under way, a bad prognosis will have to be given, for uræmic symptoms may then be expected at any moment, or a fatal typhoid is apt to be inaugurated. If the voided urine contains much albumen, a small proportion of urea, and but little sodium chloride, besides having a low specific gravity, the cholera-typhoid is prognostically almost certain. But the opposite signs may be taken as indicating a favorable turn. Yet again it must be insisted upon that, even when this favorable turn at so late a period has occurred, joy and congratulations may be turned once more to sorrow and despair by a return of former symptoms that will now surely carry the patient to his grave.

A rather unfrequent complication incident to the stage of reaction, is mentioned by Macnamara. It is the formation of a heart-clot in the right cavities usually extending into the pulmonary artery and its larger branches. It appears to be more common among natives of India than among Europeans. The symptoms are thus described by the author cited: "The patient seems to be doing well, when suddenly difficulty of breathing comes on, followed by collapse and death."

Prognosis in the Typhoid Condition depends much more exclusively upon the character and amount of urine secreted than in the stage of reaction. There may be complete urinary suppression early in the development of the cholera-typhoid, and yet a return of the flow with an increasing tendency to normal renal activity will justify a favorable prognosis. When, however, the kidneys are "fickle," giving now promise of repair, and again destroying that promise by a cessation of function, the prognosis is bad.

Drasche has tersely said, "Typhoid with urine is more favorable than typhoid without urine;" and there is much truth in this dictum.

The appearance of well-marked cholera exanthem in the typhoid state is, if anything, a good omen. But the visible deposition of urea upon the surface of the integument is a bad one. The appearance of bloody stools may be regarded as a fatal sign. If a patient has had the good fortune to escape the Scylla of an attack of cholera, as well as the Charybdis of reaction and typhoid, smooth waters are at length encountered. For experience has amply shown that death from any later complications and sequelæ is exceptional, and one feels tempted to add avoidable. Judicious management with the intelligent coöperation of the patient in the vast majority of cases ought to land him safely on the grateful shores of final recovery. From the foregoing it will readily be seen that the prognostic signs of a fatal issue are far more numerous, clear and reliable than those denoting the opposite. This unfortunate circumstance belongs to the nature of the disease, and cannot be justly construed as a reproach to medical skill and learning. An apparently favorable sign is much more apt to mislead the unwary or inexperienced, by being made too much of, than that a fatal prognosis is happily put to naught by an unexpected turn in the condition of the patient. Pessimistic forethought is scarcely anywhere more applicable than in an acute attack of epidemic cholera.

CHAPTER XXXVII.

ON THE METHODS OF BACTERIOSCOPY AND THE PREPARATION OF PURE CULTURES.

THE detection and identification of the cholera-bacillus, and indeed of all micro-organisms, is so entirely dependent upon the skillful employment of special technical methods, only quite recently elaborated, that a succinct account of the subject is here given. It is now universally admitted that Koch's method, as pursued at the Imperial German Health Board, constitutes the most perfect one yet devised for exact bacteriological researches.

It is proper to state, however, that the technique as described by him in the first volume of the "Mittheilungen aus dem Reichsgesundheitsamt," published in 1881, has, especially in its application to cholera, undergone certain changes, mainly in the direction of simplification. And it may be affirmed without exaggeration that, in its present shape, this method is the most reliable one, by far, where precise data concerning the biology of the micro-organisms in question are to be obtained.

If any argument were needed to establish the importance of the subject of bacterioscopy, it might be found in the consideration that an adequate acquaintance with these modern methods of investigation is quite essential, even to the formation of a correct judgment concerning the present status of the cholera question. Dr. Biedert has described the improved methods very clearly,[1] and the following account is partly based on his description:[2]

It is well to remember at the outset that, all test tubes, flasks, filters, knives, platinum wires, etc., are always thoroughly sterilized by overheating, immediately before being used. The mouth of a test-tube while still hot is plugged by sterilized cotton-wool. Double plugs are generally better than single ones.

The diagram on the next page, taken from Klein,[3] shows a convenient apparatus for sterilizing flasks, test-tubes, cotton, etc.

The use of fluids for purposes of artificial cultures is not advisable in the study of cholera-organisms, having been superseded by a number of solids that answer all practical requirements in a very satisfactory manner. The principal substances now employed as solid culture media are boiled potatoes, prepared gelatine, and coagulated blood serum. The first two of these, and especially the second, are employed in cholera investigations, while the third is chiefly used for cultures of tubercle bacilli.

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[1] More detailed descriptions are given by Prof. A. Johne, and the best exposition of the entire subject of the methods of bacterial research is found in a work just issued and entitled "Die Methoden der Bakterien-Forschung," von Dr. Ferdinand Hueppe, Wiesbaden, 1885.

[2] Deutsche Medicinal Zeitung, Nos. 103 and 104, 1884.

[3] Micro-Organisms and Disease. By E. Klein, M.D. London, 1884.

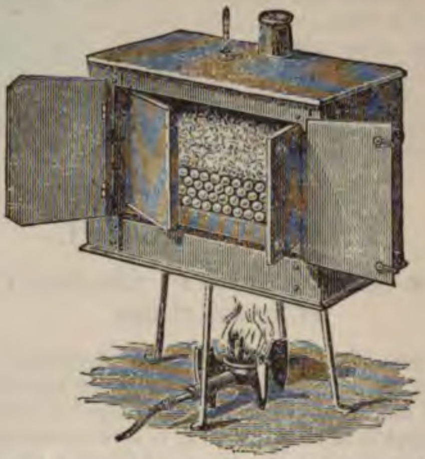

FIG. 9.—Hot box for sterilizing. (An iron chamber with double wall, the inner chamber having separate folding doors. In the inner chamber are placed the test-tubes, cotton-wool, etc. Both sets of doors are closed and the apparatus heated by a large Fletcher's burner. The thermometer passing out from the inner chamber indicates its temperature.)

The potatoes are first thoroughly cleaned by scrubbing and then placed for an hour in a solution of corrosive sublimate (5-1000). Next they are cooked in a steam sterilizer.

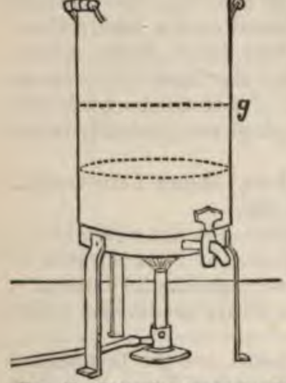

FIG. 10.—Steaming apparatus for sterilizing potatoes, etc.

The adjoining figure represents a convenient form of steaming apparatus of this kind (London Lancet, September 27, 1884). It is a cylindrical box with a conical lid. An iron grating (*g*) is fixed at a level below the middle, and serves to support what has to be steamed. The water is poured in from above, and heated by a Bunsen burner. The box and lid are invested by a thick layer of felt, which reduces the loss of heat, and so maintains the interior at a uniform temperature. A hole in the top of the lid admits a thermometer, which is held in place by cotton-wool. Having been thoroughly sterilized, the potatoes are now sliced with a knife heated immediately before to redness, and after implantation with the suspected material, care being taken that the fingers, although washed in sublimate solution, do not come in contact with the cut surfaces, they are laid aside under suitable cover. The colonies growing on the potatoes may be removed for examination at any period of their development.

To prepare blood-serum as a medium for cultures requires much more care than the simple sterilization of potatoes. The blood-serum, in order to prevent coagulation, is prepared by heating it once a day for eight days up to 135° F.[1] This destroys only the bacteria each time, and not the spores. But as the latter become developed from day to day into bacteria, they are in turn killed, and in this way at the expiration of eight days the process of sterilization is completed.

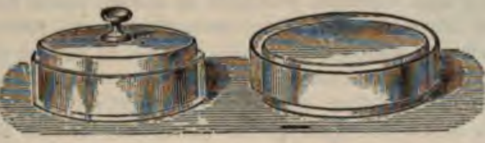

FIG. 11.—Receptacles and covers for potato-cultures.

In order to solidify it, the serum is then heated up to 159° F., not any higher lest it become turbid, and is so poured into test tubes as to prevent a broad sloping surface exposed to the air.

The accompanying diagrams illustrate Koch's apparatus for the sterilization of blood-serum. It consists of a double cylinder made of sheet copper and provided with a hollow lid. The cylinder is half filled with water, the hollow lid likewise contains water. The lid has three openings into which thermometers are fitted. One of these shows the temperature of the water in the lid, another that of the air in the cylinder, and the third that of the water in the cylinder. The manner of heating the water both in the lid and in the cylinder appears from inspection of the figures. As already intimated, however, an apparatus of this kind is not essential for the diagnostic recognition of cholera-bacilli.[1]

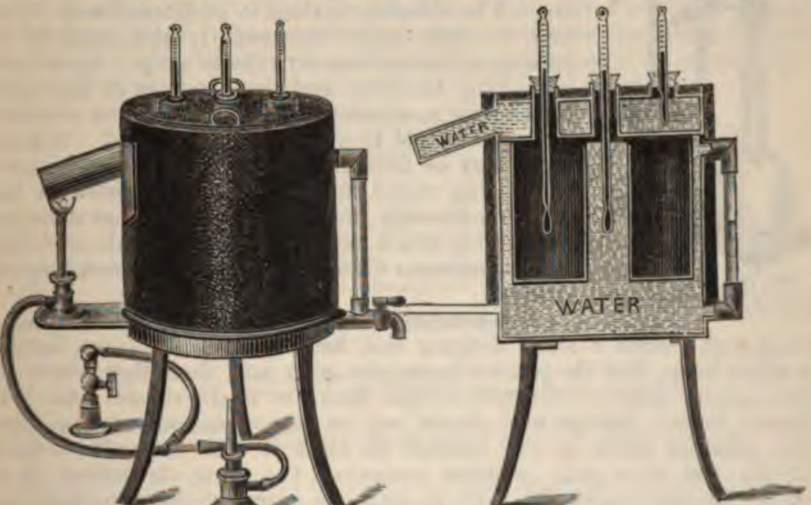

FIG. 12.—Koch's apparatus for the sterilization of blood-serum.

For this purpose gelatine cultures are now quite generally employed, since they possess unmistakable advantages over the other media. To prepare them the gelatine must be mixed with some vegetable infusion, or what is preferable, with peptonized meat broth. The present mode of preparing the latter is as follows: One-quarter of a kilogram (one-half pound) of chopped meat (lean beef), is placed in a half litre (one pint) of distilled water and allowed to stand in a cool place for 24 hours. It is then strained through gauze and brought up to 400 ccm. (about 13 ounces), and to it are added 2 grm. (30 grains) of salt, 4 grm. (60 grains) dried peptone (*peptonum siccum*, Witte), and 40 grm. (600 grains) pure commercial gelatine. After standing for half an hour the mixture is warmed slightly until the gelatine is dissolved, and is then neutralized with a saturated solution of carbonate of soda, until it will just turn red litmus paper blue. It is then carefully boiled over a water bath for at least an hour, until all the albumen is separated and the fluid becomes colorless. A small quantity of this filtered and heated in a test tube should give no cloud, or at the most only a very faint one, for the gelatine must be very clear and transparent for use under the microscope. A very faint milkiness may be caused by heating, even when the fluid is entirely free from albumen; this is due to the presence of phosphates, and disappears on cooling. The solution is then to be filtered hot. This may be done quite conveniently and speedily by passing a Bunsen burner rapidly around the funnel containing the filter and thus keeping it hot until the process is completed. It must be done carefully in order to avoid breaking the glass funnel. A spirit lamp may be used instead of the Bunsen burner, care being taken not to spill the alcohol in the rapid movements necessary. A somewhat more expensive but much better plan is to provide one's self with a hot-water filter, as shown in the accompanying diagram.

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[1] This is really Tyndall's method of sterilization by discontinuous heating. See his Essays on the "Floating Matter of the Air," second edition, 1883.

[2] J. F. Luhme & Co., Berlin N. W., Friedrichsstrasse 100, supply all the utensils and apparatus required for the employment of Koch's methods.

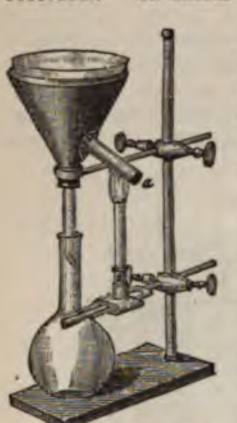

FIG. 13.—Hot-water filter for gelatine meat-solutions, etc.

The test tube is now prepared by introducing a pledget of cotton a short distance and heating over a Bunsen burner or spirit lamp, first the portion below the plug and then that above it. The cotton, slightly browned by the heat, is finally seized with previously heated forceps and drawn up to the open end of the tube. The gelatine broth is now poured in until it fills not quite a third of the test tube and, without removing the plug, is boiled thoroughly on four successive days in order to insure perfect sterilization. Care must be observed during this process not to wet the cotton if possible. A light cloud of phosphates may be formed at each boiling, but, as before mentioned, disappears again on cooling. After a few weeks such gelatine becomes unfit for use, through evaporation which takes place through the plug. This may be prevented by covering the mouth of the test tube with gutta-percha tissue. In this way the gelatine may be preserved unchanged for a long time, but it is better to heat the upper portion of the tube containing the wadding, once in a while, to make sure that the sterility of the solution is maintained.

When employed for plate cultures the gelatine material is poured out in a very thin layer on glass, and simply left uncovered if the germs in the atmosphere are to be studied, or sprinkled with dust from the ground if that be the subject of investigation. When other matters containing microbes are to be examined they are mixed with the gelatine before it is poured from the test-tube. The gelatine is first liquified by careful warming, and then, for the sake of greater security, is boiled once more and afterward allowed to cool to about the temperature of the body, in order that the microbes about to be studied may not be injured by too great heat. A small drop or a minute piece of the matter to be subjected to the culture experiments—for example a bit of suspected cholera dejection—is taken up by a loop of previously heated platinum wire, and put into the fluid held inclined in the test tube, then after replacing the cotton plug the tube is inclined from side to side in order to diffuse the material thoroughly through the fluid gelatine.

But the gelatine is not yet ready for the plate cultures. For after one or several days the numerous bacterial forms contained in the material employed (suspected intestinal matter, for example), will have increased to such a degree that it becomes impossible to isolate each or any particular kind. It is necessary, therefore, to still further separate the different bacterial groups by dilution. To this end, as soon as the material is well diffused through the gelatine in the first test tube, three drops are taken out by the looped platinum wire and put into a second tube; then after thorough admixture three drops are taken from this in the same way and placed in a third tube. The contents of the three tubes are then poured out on glass plates. The gelatine from the second tube sometimes answers the purpose, but that from the third is generally found to contain the microbes in just about sufficient number.

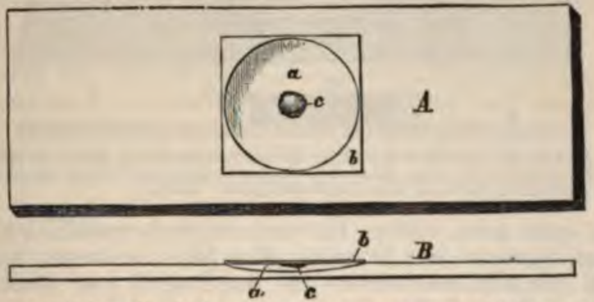

FIG. 14.—Excavated glass-slide; *A*, from above; *B*, in cross section; *a*, the moist-chamber; *b*, the cover-slip; *c*, the drop of fluid containing the bacteria to be studied.

At the end of from one to four days the bacterial colonies may be seen with the naked eye as little points in the gelatine, and if they seem to be numerous enough and yet discrete, the plates are to be examined under the microscope with a low magnifying power, of 100 diameters or so, in order to determine the condition of the gelatine and to see that the particular colony sought for is isolated and that no other lies above or below it, or too near alongside. This particular colony having been accurately located, may usually be picked out from the gelatine without the aid of the microscope, by means of a previously heated platinum needle. But the plate should always again be examined microscopically to make sure that the colony sought for and no other one has been touched in the process of removal.

In case the colony is too small or lies too near another to allow of separation, when viewed with the naked eye alone, the operation must be done under the microscope; a little practice renders this easy of accomplishment.

The organisms thus obtained with every guarantee of perfect purity may now be studied in a variety of ways. When they are to be used as stained preparations a drop of water is first brought on a cover glass and impregnated with the mass; this is then dried in the air or with gentle heat, drawn three times through the flame, stained with an aqueous solution of fuchsine, rinsed with water and placed under the microscope. The microbes must be all of the same kind, and when there are spores they should be little or not at all stained.

The bacterial colonies may also be examined in excavated slides, either in water to study their movements, or in meat broth to observe their development. The latter is prepared in exactly the same way as the gelatine culture medium except that no gelatine is added. A minute particle is placed with a drop of water or broth on a cover glass and then put over the hollow in the slide. The edges of the excavation are greased with a little vaseline so that with the cover glass it forms a moist chamber protected from the air. In water the movements of the micro-organisms may be readily observed, and in the broth we may watch the microbes growing in a pure culture. In order to insure the purity of the culture, the cover glass should of course be previously sterilized by passing it through the flame of a spirit lamp. Since the preparation is unstained a diaphragm with a small aperture must be used. The Abbé condenser, which is used for stained preparations without the diaphragm, may remain. But a better kind of glass cell than the one just described is made by cementing a glass ring about three-fourths of an inch in diameter and about one eighth of an inch high, on to an ordinary glass slide. By placing the previously heated cover glass over this ring, the upper edge of which is smeared with a little vaseline, a very convenient chamber is secured. The bottom of the cell receives a little drop of water in order to insure the necessary degree of moisture in the cell. A glass cell of this kind may be kept on a warm stage, for any length of time.

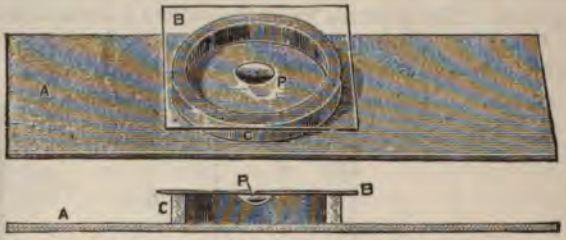

FIG. 15.—A glass cell for observing under the microscope the progress of growth of micro-organisms. *A*, glass slide; *B*, cover glass; *C*, glass ring forming the wall of the chamber; *P*, drop of nourishing material in which the micro-organisms grow. (Klein.)

Another proving may be made by transplantation of the material obtained in the manner above described to a sliced potato. The mode of growth on this medium furnishes a new biological characteristic of the particular microbe. Potatoes may also be used to obtain pure cultures from mixed material. The latter is spread over a wide area of the cut surface, then a little is taken from this and smeared over a second slice, and again some from this to be spread over a third piece, a method which is seen to be analogous to the dilution practiced in plate cultures. This is, however, not to be compared, as regards the certainty of having really obtained a pure culture, with the gelatine method, since it is impossible to verify results at at every stage with the microscope.

The necessity of a microscopical control of all cultures is a point to be insisted on, and one that is not generally appreciated. Trusting merely to naked-eye appearances is liable to lead to fatal errors in seeking after pure cultures.

Any number of pure cultures can now be easily made by putting a particle of the colony removed as above described from the plate cultures by means of a platinum needle, into the sterilized gelatine in a test tube. The transplantation is effected while the tube is held inclined at an angle or reversed, and immediately it is accomplished the cotton plug is replaced. If the operation have been successfully done the microbes will remain isolated and unmixed during their entire life in the new soil. According to Van Ermengem[1] cholera bacilli will live six or seven weeks in the gelatine media in test tubes.

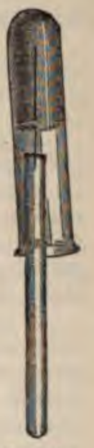

FIG. 16.—Method of inoculating the gelatine material in a test-tube.

A practical point concerning the technique of plate cultures may here be mentioned. In the laboratory of the Imperial Board of Health, at Berlin, the glass plates used for this purpose are about 6 inches long and 4 inches wide; and they are just suited to receive the gelatine contained in one test tube. But in order to use plates of this size the microscope must be provided with a very large stage. When the stage is not of sufficient size it is better to use smaller plates. Biedert makes them 2 inches wide and 4 inches long, thus using two of them to receive the contents of a single tube. Another advantage in using two smaller plates is that while examining one, the second may be kept under cover protected from the air and other sources of contamination. Before being used these plates must be sterilized, at least on one side, by passing them through a flame that does not smoke; they are then laid aside with the heated side uppermost and covered at once with a watch glass or a plate, and should not again be touched on the sterilized side. Three pairs of the small plates being now ready, the gelatine in three tubes is impregnated with the suspected material, as above described, and then being allowed to cool until it is just about to stiffen, is poured out on the plates. Some little experience is necessary to determine just the proper time for doing this. By means of a sterilized glass rod the gelatine is now spread rapidly and evenly over the plates, covering their entire surface, except for a space about one-fifth of an inch wide at the edges. The plates of course must lie horizontally, and are covered again at once until the gelatine is firmly set. The culture is now left to grow in a moist chamber. If a watch glass is used, a piece of moistened blotting paper may be put in the glass trough in which the plates are set. Or the glass-plates can be laid on moistened blotting paper between two ordinary dinner plates.

A very convenient apparatus for maintaining glass-plates, slides, etc, in a horizontal position, and at the same time subjecting them to the action of cold in order that the gelatine may quickly solidify, is represented in the adjoining figure.

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[1] Contribution à l'Étude du Microbe du Choléra. Communication made to the Belgium Microscopical Society at its meeting of Oct. 26, 1884. Reported also in the Deutsche Medical Zeitung, vol. ii., 1884, p. 498.

The glass plate *g* rests on a triangle made of wood, and by regulating the screws a perfectly horizontal position can be maintained. Pounded ice or snow can be placed under the glass plate to effect rapid cooling. Moistened blotting paper should be placed in the glass receptacle before it is covered.

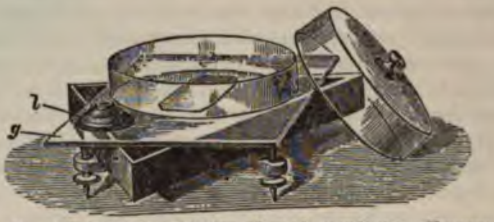

FIG. 17.—Apparatus for gelatine glass-plate cultures. Hueppe.

In the examination of cultures thus obtained from mucous flocculi taken from cholera dejections, the decisive work begins in 24 to 48 hours after the preparation of the plates. In examining now the larger or smaller sunken points with a low magnifying power, some of the peculiarities characteristic of comma-bacilli cultures are made manifest. The distinguishing features of these bacilli, when examined in the various ways above described, may be briefly set forth as follows:

1. In plate cultures (low power, 90–100) a whitish spot with irregularly indented borders is seen. It appears to be made up of granules with a glossy luster. In consequence of the sinking in of this spot with the formation of a bubble of air, it seems to be surrounded by an area, at first shining, with a reddish, mother-of-pearl tint, and later black; in the center of this lies the whitish glistening colony. There is later a little more marked but never an extensive liquefaction of the gelatine.

2. In pure cultures in the test tube there is a funnel-shaped sinking in of the whitish colony, with fluidity of the medium below and the formation of an air bubble above. Fine white lines may be seen extending downward. In eight days there is extensive liquefaction of the gelatine.

3. In broth cultures in hollow slides, after 24 hours, swarms of quickly-moving bacilli are seen with many long screw-shaped spirilla in the center of the drop. At the edges beautiful commas lying closely crowded together are readily detected.

4. In stained specimens are seen the little curved rods of equal width throughout, about half as long and of the same thickness as tubercle bacilli. They are often joined together in S or U shapes. When the preparations are made from cultures in hollow slides the bacilli often form beautiful long spirilla, which are thicker and have less pronounced curves than the salivary spirilla.

5. No spores are ever found in the stained preparations, no matter at what period of the culture they are examined.

6. Another characteristic of the cholera commas is their rapid death when dried. Biedert states that he found a culture in a hollow slide dead ten minutes after drying, and it is the rule that no more livin gbecilli are to be met with longer than one or two hours after thorough drying.

7. The growth of these micro-organisms is retarded or arrested by moderately low temperatures or in acid culture media. (Van Ermengem[1]

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[1] Loc. cit.

has, however, observed them develop, though very slowly, in temperatures between 46° and 58° F.)

8. They are seen to grow under a thin, dark, yellowish brown covering in potato cultures in an incubator; but this does not occur at ordinary temperatures.

These several characteristics present the sharply defined picture of a special organism. But they are only observed in pure cultures, except those described under the fourth heading, and even these are seen most clearly in pure cultures alone. This important point is now universally conceded by those most competent to judge. And even Klein, who as has been shown, opposes Koch in almost every particular, is compelled to admit that the comma-bacilli of cholera constitute a distinct species. In his most recent publication, entitled "Some Remarks on the Present State of our Knowledge of the Comma-bacilli of Koch," he says:[1]

"As far as the observations hitherto go, there is no doubt whatever, that the comma-bacilli of Koch are a distinct species, characterized by their behavior in cultivations in gelatine-material, and that this distinct species occurs in the intestine of human beings suffering from cholera; but whether they occur here in numbers in consequence of the peculiar condition of the intestine in this disease, or whether they are the cause of it—that is to say, whether *post hoc* or *propter hoc*—is, I maintain, an open question, which Koch has not proved, and which he has not attempted to prove. And this question will remain unanswered until the examination of the intestine, under precisely similar but not choleraic conditions (that is, distension of the intestine, and exudation into it of clear fluid and mucus flakes) is made, and until it is found that these same comma-bacilli are always absent." It appears, therefore, that Klein now disputes the diagnostic significance of the detection of Koch's commas in a rather conditional and half-hearted way, and not in a manner to convince one that he feels sure that he is right and Koch is wrong. Doubtless the last word in the matter has not yet been spoken.

Meantime it may be interesting to know that, as stated by Dr. Heron,[2] Koch is prepared to start at short notice, with a band of competent assistants, to examine into and ascertain by this method the exact nature of any case of supposed cholera which might occur in Germany. The investigation would take not more than a few days, and during that time the suspected person or persons could be most rigidly isolated. There is reason to hope, therefore, that Dr. Koch's great influence will be thrown on the side of medical inspection, against quarantine.

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[1] The British Medical Journal, April 4, 1885.

[2] Editorial on the Etiology and Diagnosis of Cholera, published in the British Medical Journal, April 4, 1885.

PART SIXTH.

THE PREVENTION OF CHOLERA.

SECTION I.

THE DESTRUCTION OF CHOLERA GERMS.

BY

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CHAPTER XXXVIII.

THE DESTRUCTION OF CHOLERA GERMS—EXTERNAL AND INTERNAL DISINFECTION.

General Remarks.—The writer of the present chapter, while admitting that it is not definitively proved that the "comma-bacillus" of Koch is the veritable germ of cholera, considers the experimental evidence in favor of this view to be of such a nature as to make it highly probable that such is the case.

That a micro-organism of some kind is concerned in the etiology of cholera can scarcely be doubted. A multitude of facts relating to the origin and extension of the disease, to the conditions governing its epidemic prevalence, its modes of transmission, etc., gives support to this views.

It is certain that something contained in the dejections of cholera patients is competent to give rise to the disease in others, either directly, as when washerwomen contract the disease from handling soiled clothing, or by the establishing of new epidemic foci as a result of the external development of this "something," *when conditions are favorable* and the alvine discharges of cholera patients are scattered broadcast without previously undergoing disinfection.

It is extremely probable that the spirillum, so-called "comma-bacillus," which has been demonstrated by the researches of Koch and others to be constantly present in the intestinal contents of the victims of cholera, and in the rice-water discharges which characterize this disease during life, is causative of cholera. In what follows we shall keep this probability in view, and our practical directions relating to disinfection will have reference to the destruction of a germ which has no resting stage, *i.e.*, which does not form endogenous spores.

In advance of the exact knowledge of this particular organism which we owe to the researches of Koch, we had indirect evidence that the cholera germ must not form resting spores, such as give to known bacilli their great power of resistance to chemical reagents and to high temperatures; for in this case it would be difficult to account for the fact that this disease does not obtain a lodgment in regions outside of the area in which it is indigenous, and that after a brief period of epidemic prevalence it disappears. After having been introduced into our own country, for example, it prevails for a certain length of time, then dies out, and does not return except in consequence of a fresh importation.

With this brief introduction, we proceed to consider the means at our command for *the destruction of cholera germs* external to the bodies of infected individuals—with reference to prophylaxis, and the therapeutic possibilities suggested by our knowledge of the germicide or restraining power of various chemical agents upon micro-organisms of this class.

External Disinfection.—It is evidently of paramount importance, in our efforts to restrict the extension of cholera, that all germs be destroyed before they fall upon that favorable soil for their development which is found in sewers, cesspools, and foul places generally. In the sick room we have these infinitesimal enemies at an advantage, for we know where to find them and how to kill them. Not to destroy them under these circumstances, and with a full knowledge of their malignant potency, would be nothing less than criminal negligence.

Recent experiments have demonstrated that many of the agents which have heretofore been relied upon as disinfectants are completely untrustworthy when the object in view is the complete destruction of disease germs. Popularly an agent which destroys or masks offensive odors is called a disinfectant; and many physicians and chemists still regard any agent which arrests putrefaction, antiseptic, or which destroys putrefactive products, as a disinfectant. From our point of view, a disinfectant is an agent which destroys the infecting power of infectious material. A disinfection consists in the complete accomplishment of this object. An agent, therefore, which restricts the development of disease germs without destroying their vitality and power to develop subsequently in the presence of favorable conditions, is not a disinfectant. When filth cannot be entirely destroyed or removed from the vicinity of human habitations, there can be no doubt as to the desirability of treating it with chemical agents which arrest putrefactive decomposition, and which at the same time make it unfavorable soil for the development of disease germs. This is especially true during the prevalence of epidemics. We therefore favor the liberal use of antiseptics when the complete removal or destruction of putrescible material is impracticable. For this purpose the metallic sulphates and chlorides now extensively used are to be recommended. On the score of economy and efficiency the commercial sulphate of iron is perhaps entitled to the first place. But when the object is to disinfect, *i.e.*, to destroy the developing power of disease germs, these agents are entirely unreliable. My experiments published in the American Journal of the Medical Sciences in April, 1883, show that *pure* sulphate of iron in saturated solution does not kill micrococci or bacilli without spores; and sulphate of zinc in the proportion of 20 per cent. failed, in two hours time, to destroy micrococci obtained from the pus of an acute abscess. According to Arloing, Cornevin and Thomas, exposure for 48 hours to a 20 per cent. solution of sulphate of iron does not destroy the virus of symptomatic anthrax, which contains spores. Dr. Duggan has recently tested, at my request, the germicide power of the sulphate of copper, and reports that a 30 per cent. solution of this salt added to an equal quantity of "broken down" beef tea does not destroy the vitality of the contained organisms in two hours time. The authors above quoted found that 48 hours exposure to a 20 per cent. solution was successful in destroying the activity of dried virus of symptomatic anthrax. The exact germicide value of cupric sulphate for micrococci and bacilli without spores has not yet been determined; but while it is doubtless more potent than the ferric or zinc sulphate, there is no reason to suppose that it will be of any great practical value for *disinfection* on a large scale.

The metallic chlorides have greater germicide potency, but this is not sufficient to justify their use as disinfectants when large masses of material are to be dealt with, as in privy vaults, etc. The same may be said of carbolic acid and of a majority of the proprietary "disinfectants," so-called, which are in the market. It does not require the application of biological tests to decide upon the comparative value of these agents as deodorizers. Any one with a good nose may judge of this matter, and there is nothing to be said against the use of any one of them for the purpose mentioned, or for the arrest of putrefactive decomposition. But, unfortunately, many of these agents have been recommended as disinfectants by physicians and by chemists, and now enjoy the confidence of the public as destroyers of disease germs, when the only evidence of such supposed potency is that obtained by the application of the nose test. The only reliable tests of disinfectants are those in which the proof of disinfection consists in the destruction of infective virulence as shown by inoculation experiments, or of the vitality of disease germs, or of non-pathogenic organisms of the same class, as shown by failure to grow in suitable culture media. Exact experiments of this nature have given us a very satisfactory list of disinfectants, and have shown with sufficient precision for practical purposes their comparative value, and the limits of their germicide power. Although no experiments have yet been published which relate directly to the power of these agents to destroy the "comma-bacillus" of Koch, it is entirely safe to take as a guide the results obtained in experiments on similar organisms, pathogenic or non-pathogenic, with the simple precaution of keeping on the safe side as to the amount of the disinfecting agent used, and the time of exposure to its action, in applying in practice the data obtained by carefully conducted laboratory experiments. This is not the proper place to give in detail the experimental data which form the basis of the methods of disinfection recommended in the present chapter; and those who desire fuller information as regards the nature of the biological tests employed, and results attained, are referred to the preliminary reports of the Committee on Disinfectants of the American Public Health Association, published in the Medical News, Philadelphia.[1]

We shall consider here only those agents which have been proved to be of practical value, and it will be our aim to indicate the circumstances under which one or the other may have the preference, and the best methods of applying each in order to accomplish the object in view.

Dry and Moist Heat.—All micro-organisms not containing spores are quickly destroyed by contact with water or steam at a temperature of 212° Fahr. We have therefore always at hand an extremely simple method of disinfecting clothing, bed-linen, etc., which has been soiled by the discharges of cholera patients. It is only necessary to put them through the ordinary process of washing in boiling water, or to subject them in a properly constructed chamber to the action of steam. A considerably lower temperature than that of boiling water is fatal to micrococci and to bacilli in active growth, in the absence of spores; and it is only for the purpose of keeping on the safe side, and because it is quite as easy in practice to "bring the water to a boil" as to stop the process at a lower temperature, that we insist upon boiling.

We have already remarked that the spirillum of Koch—his "comma-bacillus"—does not form spores, and that even if this proves not to be the true cholera microbe, there is reason to believe that we have not to deal with a spore-bearing organism. If such were the case a temperature above that of boiling water would be required, for the spores of many bacilli resist this temperature for a considerable time. But the most resistant spores known are destroyed in a few minutes (10) by a temperature of 105°C. (221° Fahr.), and it is very easy to attain this temperature by means of superheated steam. It is safe to say that all known disease germs would be destroyed almost instantly by contact with steam at a temperature of 110°C. (230° Fahr.), and the most rigid exactions at ports of entry for the disinfection of clothing or merchandize by steam need not go beyond this. Wherever it can be applied, disinfection by steam is unquestionably one of the most effectual and economical methods at our command. Recent experiments, made by the writer at the request of the Health Officer of the Port of New York, show that it is even practicable to disinfect rags in the bale, by injecting steam at a high temperature into the interior of the bale through hollow metal screws.

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[1] The reports thus far published are upon Chlorine, Bromine and Iodine in the number of the Medical News dated January 25th, 1885; Commercial Disinfectants, Feb. 7; Mercurial Chloride, Feb. 21; Dry and Moist Heat, March 14; Carbolic Acid, March 21; Sulphur Dioxide, March 28; Disinfectants, April 18, 1885.

In hospitals and for domestic disinfection *immediate immersion* of soiled articles in boiling water should be insisted upon, unless it is considered more convenient to place these articles in a cold solution of mercuric chloride until they can be sent to the wash-house. Under no circumstances should such articles be sent out of the house to be washed, or laid aside for a time, without having been first disinfected; for it is well known that washerwomen are liable to contract cholera from handling such clothing, and in this way the disease may be propagated before the measures intended to restrict its extension are put in force. Dry heat is far less effective than moist, and Koch has shown that certain spores will resist a temperature which injures woolen fabrics (140°C.). A temperature of 100° C. (212° Fahr.) maintained for one hour and a half will, however, destroy bacteria without spores. This makes it practicable to disinfect woolen garments used by cholera patients, and other articles which would be injured by steam or by immersion in boiling water, by placing them in a properly constructed dry oven. Every quarantine establishment should be provided with such a disinfection chamber, and it will be as well to use a somewhat higher temperature than that mentioned. Exposure for one hour to a temperature of 110°C. would no doubt be effective for articles freely exposed. But it must be remembered that in dry air the heat has very little penetrating power, and that packages of any kind, or even clothing loosely piled up in the disinfection chamber, are likely to escape complete disinfection.

What has already been said as to the disinfecting power of moist heat furnishes a precious indication for prophylaxis during the epidemic prevalence of cholera. Food or water which has been *recently* heated to the boiling point will not convey living cholera germs to the interior of the body. As it is undoubtedly true that a vast majority of the cases during an epidemic result from the ingestion of contaminated drinking water, or of food containing active cholera germs, it is evident that individual and domestic prophylaxis is a comparatively simple matter. If there is the slightest ground for suspecting that the water supply is impure, it should be boiled. After boiling it may be cooled by the use of good pond ice—*i.e.*, ice not manufactured during the summer months and possibly from impure water. The boiling of milk shortly before it is used is still more imperative, and cold dishes of meat, fruit, or vegetables, which have been set aside for a time, should be looked upon with suspicion.

Mercuric Chloride.—Recent researches have shown that corrosive sublimate, both on account of efficiency and comparative cheapness, is entitled to a leading place among those agents upon which we may rely as disinfectants. In a paper upon this salt, in which the writers own experiments are considered in connection with those of Koch and others, published in the Medical News of Feb. 21st, 1885, the following conclusions are reached:

"Mercuric chloride, in aqueous solution, in the proportion of 1:10,000, is a reliable agent for the destruction of micrococci and bacilli in active growth not containing spores; and in the proportion of 1:1,000 it destroys the spores of bacilli—provided that the micro-organisms to be destroyed are fairly exposed to its action for a sufficient length of time.

"A standard solution of 1:1,000 may be safely recommended for the disinfection of bedding and clothing which can be washed; for washing the floors and walls of infected apartments; for disinfecting the hands and instruments of surgeons and gynecologists; and as a disinfecting wash for superficial wounds or mucous surfaces. For continuous application to wounds, etc., a solution of 1:10,000, or less, should be effective.

"A standard solution of 1:500, with the same quantity of potassium permanganate, may be safely recommended for the disinfection of liquid fecal discharges, and other fluid material supposed to contain "disease germs," provided the time of exposure is not less than two hours and the quantity of material to be disinfected is not in excess of that of the standard solution used."

The recommendation relating to the disinfection of "liquid fecal discharges" has in view the complete destruction of all contained organisims, including spores. A much shorter time of exposure would doubtless suffice to destroy the "comma-bacillus" of Koch, or any other organism in active growth. The conditions might be modified with safety to the extent of reducing the time of contact to ten or fifteen minutes, if the material to be disinfected is thoroughly mixed with the disinfecting solution. In the standard solution recommended, potassium permanganate is introduced for the purpose of giving color to the disinfectant, and also because of its value as a deodorizer. The want of color or odor in aqueous solutions of corrosive sublimate, and the poisonous nature of the salt, might lead to accidents, especially in domestic use, on account of its being mistaken for water. The addition of the permanganate obviates this objection, and serves a useful purpose as well in neutralizing temporarily any unpleasant odor. As the permanganate is quickly decomposed by contact with organic matter, its deodorizing power is only exercised for a brief time, and in the proportion recommended its germicide value is hardly to be considered.

Taking the retail price of these salts as given in a recent copy of the American Druggist, the cost of 500 lbs. of the disinfecting fluid recommended would be:

Mercuric chloride 1 lb.	.70
Potassium permanganate 1 lb.	.65
Water 500 lbs	.00
	$1.35

In making up smaller quantities it will be well to remember that the amount of each salt required to make a 1:500 solution is two grains to the litre, or about two drachms to the gallon.

For the disinfection of soiled clothing, bed linen, and other articles which can be washed, a solution of mercuric chloride alone, of the strength of 1: 5,000, may be used; this will be about one drachm to five gallons of water. When circumstances are such that clothing cannot be immediately immersed in boiling water, upon being removed from the patient's person or bed, this will constitute the best and cheapest method of disinfecting it before sending it to be washed.

The same solution may be used to disinfect the surface of the body of the sick, the hands of attendants, and all surfaces which have been soiled with choleraic discharges.

In recommending that this potent toxic agent be introduced into the sick-room as a disinfectant, the writer is aware that there is a certain element of danger attending its use. But this may be guarded against by due care, and the dilute solution recommended could scarcely be taken by accident in sufficient quantity to produce death, as it has a distinctly metallic taste, and a tumblerful would hardly be a fatal dose. The danger is certainly not greater than that attending the use of carbolic acid, strong solutions of zinc chloride, etc.

There is another possible danger, however, which I consider it my duty to point out. The question as to the action of such solutions upon lead pipes when the disinfectant and material to be disinfected are poured into city water-closets, etc., is an important one. This question is being considered by members of the Committee on Disinfectants of the American Public Health Association, and their report will doubtless be published within a short time.

It is hardly necessary to give the caution that in practice solutions of mercuric chloride must be kept in glass, iron, or wooden vessels. Receptacles made of any one of the metals with which mercury forms an amalgam, would not only be injured by contact with such solutions, but would destroy their disinfecting power by decomposing the mercuric chloride.

The Hypochlorites of Soda and of Lime occupy the first place among the oxidizing disinfectants on the score of economy and efficiency. The value of the *liquor sodæ chlorinatæ* of the Pharmacopœia depends upon the amount of hypo-chlorite of soda which it contains, and this may be conveniently measured by estimating the chlorine.[1] The popular idea, however, that the disinfecting power is directly due to the evolution of chlorine is an error; and the direction sometimes given by physicians to hang up cloths moistened with this solution in the sick-room, with a view to disinfect the atmosphere, is based upon a mistaken conception of its action. In contact with organic matter the hypochlorite is decomposed and a large quantity of nascent oxygen is liberated, which is the active agent in accomplishing the destruction of micro-organisms present. The same is true as regards the chloride of lime, or bleaching powder, which owes its disinfecting power to the presence of the hypochlorite of lime. It is a popular notion, which is shared by many physicians, that the virtues of chloride of lime as a disinfectant depend upon the gradual liberation of chlorine, and that when placed in open vessels in the sick-room, or in foul places, it will act as an atmospheric disinfectant. Its value when used in this way is extremely limited, for it is a well-established fact that the presence of chlorine, or of any other gaseous disinfectant, in the atmosphere, in respirable quantity, is quite inadequate for the destruction of disease germs. But the hypochlorite of lime, which is freely soluble in water, and which is present in properly prepared chloride of lime in the proportion of 20 to 40 per cent., is a most potent oxidizing disinfectant. The hypochlorites are not quite as pleasant to use in the sick-room as the odorless solution of mercuric chloride which we have recommended, but, on the other hand, they are deodorizers as well as disinfectants, and destroy noxious effluvia as well as germs, without being decidedly objectionable on account of their odor. For the disinfection of excreta the hypochlorites are to be especially commended on account of their prompt action, and because they are free from the objection which suggests itself with reference to the use of mercuric chloride—viz., a possible injurious action upon lead pipe.

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[1] See Dr. Duggan's report in the Medical News, Feb. 7, 1885, p. 147.

Labarraque's solution, as found in the market, differs considerably in value, which, as stated, is estimated in terms of chlorine. A solution containing two per cent. of available chlorine promptly destroys germs of all kinds, including spores. When diluted with four or five parts of water, for the destruction of cholera germs and other organisms not containing spores, in liquid fæces, such a solution could doubtless be diluted with safety to one part in twenty, the time of contact being two hours. But as in practice there will be a disposition to make the time of contact as brief as possible, and to empty the contents of a vessel containing choleraic discharges into the nearest water-closet or privy vault as soon as possible, we think it best to insist upon the use of comparatively strong solutions. It will be understood that in all of the practical directions given for the disinfection of excreta the amount of the disinfecting solution used must equal that of the material to be disinfected. When used in the liberal manner which we advise, the question of cost becomes an important one. If this solution is to be purchased from retail druggists in quart bottles the cost of disinfection in a case of cholera or of typhoid fever will often be beyond the means of poor persons. But we hope to see this and other reliable disinfectants furnished by health officers, or by their authorized agents, by the gallon, or barrel, at a price which will bring them within the reach of all, or better still at the expense of the public treasury. I am informed that a solution containing two per cent. of available chlorine could be sold by the quantity as low as 40 cents per gallon. This diluted with four gallons of water would give five gallons of a prompt and reliable disinfecting solution for 40 cents. Using a pint of the solution for each liquid fæcal discharge, the expense of disinfection would be one cent for each dejection.

The hypochlorite of lime, to which the commercial chloride of lime owes its value as a disinfectant, is equally effective, and still cheaper. According to Dr. Duggan this contains usually from 25 to 40 per cent. of available chlorine. One pound, therefore, dissolved in from ten to twenty pints of water would give a solution of calcium hypochlorite containing 2 per cent. of available chlorine. Diluting this to the same extent as recommended in the case of the sodium salt, we would have from one pound of chloride of lime of the best quality (40 per cent. of available chlorine) twelve gallons and a half of disinfecting solution, the cost of which would not exceed ten cents. (By the quantity chloride of lime can be purchased for four to five cents a pound.) It is hardly necessary to look for anything cheaper than this solution, and carefully conducted laboratory experiments show that it destroys the vitality of putrefaction bacteria, including various species of bacilli *and their spores*, within a very brief time.

For the disinfection of clothing more dilute solutions should be used, as, for example, one part of Labarraque's solution to 100 of water; or one ounce of bleaching powder in five gallons of water. For this purpose, however, we prefer the 1:5,000 solution of mercuric chloride heretofore recommended.

Other disinfectants might be added to the list if we had need of them, but inasmuch as they are all inferior to those already named, it is unnecessary to devote much attention to them in the present chapter. The mineral acids are all active germicide agents, and destroy spores after two hours contact when present in the proportion of 8 to 15 per cent. (sulphuric 8 per cent., nitric 8 per cent., hydrochloric 15 per cent.). In the absence of spores much weaker solutions are effective. Thus in the writer's experiments published in the American Journal of the Medical Sciences in April, 1883, it was found that sulphuric acid in the proportion of 1:200 (.05 per cent.) destroys the vitality of *B. termo* in active growth, and of the two species of micrococci experimented upon.

Sulphur Dioxide in aqueous solution—sulphurous acid—destroys micrococci and bacilli in active growth in the proportion of 1:2,000 by weight, the time of contact being two hours. But this agent is important for the destruction of spores.[1]

Commercial sulphurous acid would doubtless be effective for the destruction of cholera germs in a brief time when diluted with fifty parts of water.

Sulphur dioxide in gaseous form, as produced by the combustion of sulphur in the presence of an abundant supply of oxygen, is commonly considered one of the most reliable agents for the disinfection of ships, hospital wards, etc. There can be no doubt of its value for this purpose when the necessary conditions are observed—and especially in the presence of moisture; but recent experiments show that much of the so-called disinfection with this agent is little better than a farce; and it is difficult to determine how much of the success which is attributed to fumigation with sulphurous fumes is due to the germicide action of this agent, and how much to the subsequent ventilation and general cleaning up which sanitary officials very properly insist upon as a supplementary precaution. So far as the cholera germ—"comma-bacillus"—of Koch is concerned, it seems hardly necessary to resort to fumigations with sulphurous acid, except in the case of ships, cellars, etc., where the presence of moisture may serve to preserve the germs; for the developing power of this organism is quickly destroyed by desiccation and contact with atmospheric oxygen. Koch states that when dried in thin layers these organisms lose their vitality within three hours, and he has never succeeded in starting cultures from dried material which had been kept even in thick layers for a period of twenty-four hours.

The Metallic Chlorides possess decided germicide power, but, with the exception of mercuric chloride, they are in this respect much inferior to the hypochlorites. The solution of chloride of zinc of the pharmacopœia *liquor zinci chloridi*—destroys the organisms in broken-down beef-tea when present in the proportion of ten per cent. (Duggan.) According to Koch a five per cent. solution of zinc chloride does not destroy the developing power of anthrax spores after contact for one month.

Carbolic Acid, which for a time was regarded as the germicide *par*

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[1] See the writer's paper in the Medical News, March 28, 1885.

excellence, cannot be relied upon for the destruction of spores, but the pure acid in one to two per cent. solution destroys bacteria in active growth within an hour or two. It is safe to say that a five per cent. solution may be relied upon for the destruction of cholera germs, and of the other pathogenic organisms which do not form spores.

Hydrogen Peroxide is another agent which possesses a certain value, but owing to the want of stability and comparatively high price of concentrated solutions, it is not likely to replace the more potent oxidizing disinfectants heretofore recommended—the hypochlorites.

Internal Disinfection.—Is it practicable to destroy cholera germs in the alimentary canal, and thus arrest the progress of the disease, or prevent its development? And, if so, what agents are best suited to accomplish this purpose? It is impossible to answer these questions in a definite manner in the absence of any carefully conducted clinical experiments, but it may not be unprofitable to consider the therapeutic possibilities from the point of view of the germ-theory, and in the light of recent experiments which establish the comparative germicide value of various therapeutic agents. We naturally turn first to the most potent germicide in our list—mercuric chloride—an agent which, in the proportion of 1 part to 5000 or less, would doubtless quickly destroy all micro-organisms in the intestine, of the class to which the cholera germ is supposed to belong. The question is, first, whether it is practicable to administer this potent poison in doses which would secure its presence in the intestine in this amount; and, second, whether by accomplishing this result we can cure cholera. If we estimate the contents of the intestine at half a litre —about a pint—the amount of mercuric choride necessary to disinfect this amount of material may be put at .1 of a grain, or about one and a half grains, a quantity considerably in excess of the medicinal dose. It is evident that even if this amount of mercuric chloride could be introduced into the intestine with safety, the problem of getting it there presents serious difficulties, on account of the incessant vomiting which occurs in cholera, and because of the loss which would result from absorption through the mucous membrane of the stomach and bowels, and by the combination of the salt with albuminous material with which it comes in contact. The prospect of internal disinfection with this agent does not, then, seem very encouraging. But mercuric chloride in a much smaller proportion than that named has a decided restraining influence upon the development of bacteria of all kinds, and there is reason to believe that one-tenth of this amount—*i.e.*, one part to 50,000, or .015 of a grain—would, if constantly present in the intestinal contents, notably and perhaps entirely restrict the growth of any cholera germs, or other bacterial organisms present. This brings us quite within the medicinal dose of this agent, and to the question of the best method of introducing it to the place where it is required, with the least possible loss by absorption, and the least possible injury to the patient from its toxic action. Whether this may accomplished by the administration of calomel, which, according to some authors, is converted by contact with the chlorides of the stomach into corrosive sublimate, is worthy of further consideration; but we are inclined to agree with Dr. H. C. Wood[1] "that the action of calomel upon man is so different from that of corrosive sublimate as to render this theory exceedingly improbable." Certain it is that calomel, in heroic doses, has been thoroughly tried in the treatment of cholera, and has not been successful in establishing itself as a reliable remedy for this fatal malady. In a severe epidemic at a frontier station, which the writer passed through in 1867, the calomel treatment was employed in many cases, but without any very notable success. The impression remained upon my mind, however, that when the cases were seen early, this treatment had a certain value in favorably influencing the result. The difficulty in judging of the value of any method of treatment is greatly enhanced by the fact that many cases during the prevalence of an epidemic are not seen until fatal poisoning has already occurred. A patient in the algid stage of the disease is evidently suffering from the effects of a poison which has already been absorbed, and which acts powerfully upon the vaso-motor nervous system.

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[1] Therapeutics, Materia Medica and Toxicology, 3d ed., p. 396.

The pressing indication when a patient is seen in the stage of collapse, is evidently to neutralize the manifest effects of the toxic agent, rather than to attempt to kill the cholera germs in the intestine, which we suppose to have produced it. At the same time it is very probable that a fatal result depends, to some extent at least, upon the continued production and absorption of the poison, and we must not neglect to kill the germs, or restrict their development, if any practicable means of accomplishing this object presents itself. If the patient dies notwithstanding the administration of germicide remedies during this stage, it does not follow that treatment with agents of this class is futile. It may be, simply, that the treatment was commenced too late. To kill a murderer after his victim has been fatally wounded, does not save the life of the murdered man. Experience proves that the time for successful treatment is during the "premonitory stage," when the chief symptoms are a certain looseness of the bowels and a feeling of lassitude. The deadly germ is no doubt already present at this time; the toxic product, as a result of its vital activity evolved, is being absorbed, and perhaps has a cumulative effect, until finally the nervous centers are overwhelmed and we have the frightful symptoms of the stage of collapse rapidly developed.

That cholera is very amenable to treatment during the first stage of "premonitory diarrhœa" is generally conceded by those who have seen the most of this disease, and any abortive treatment based upon the germicidal action of the remedies employed should be applied during this stage. The object in view should be to cause the remedy to come in contact with the material to be disinfected, with the least possible loss from vomiting or by absorption. Calomel has the advantage of easy administration, and of being retained by the stomach when other remedies might be rejected. But the administration of calomel with a view to the formation and germidical action of corrosive sublimate is a very unscientific proceeding. In the first place it is uncertain whether the conversion of a portion of the calomel into bichloride occurs at all; and in the next place, it is evident that the amount formed would be so much a matter of accident that the attempt to kill germs in this way would be like shooting at a flock of partridges with one's eyes shut.

If mercuric chloride is to be fairly tested it must be administered in definite amount, and at definite intervals; and it would seem as if the indications might be best fulfilled by the administration of small amounts at frequent intervals. We would suggest, for example, upon theoretical grounds, that granules containing $\frac{1}{100}$ of a grain of mercuric chloride, mixed with milk sugar (?), and coated with some substance which does not dissolve too quickly, might be administered, two at a time, every five minutes, for an hour (= $\frac{24}{100}$ of a grain), then every ten minutes for two hours (= in all $\frac{48}{100}$ of a grain). After this one granule every ten minutes might perhaps suffice to keep the contents of the bowels in an aseptic condition. It may be that larger doses would be tolerated, or that in practice it will be found better to give the medicine in dilute solution—1:5000. The writer would not be understood as recommending a treatment which he has not tried, but simply as suggesting a clinical experiment.

The dose of liquor sodæ chlorinatæ is given by the U. S. Dispensatory as 30 drops to a fluid drachm, largely diluted with water; that of chloride of lime is said to be from three to six grains, dissolved in sweetened water. These doses frequently repeated would doubtless exercise a restraining influence upon the development of germs in the alimentary canal, but are inadequate for the complete disinfection of its contents. Both of these agents have been recommended for the treatment of "putrid" fevers and dysentery, attended with fetid discharges. Labarraque's solution is the most eligible preparation for internal administration, and the experiment of giving it in dilute solution at frequent intervals might be worth trying.

Another agent mentioned in our list of disinfectants which has doubtless a certain medicinal value, depending upon its antiseptic and germicide power, is sulphurous acid. It may be given in doses of 30 drops to a drachm, largely diluted with water, and to secure the effect desired should be given at frequent intervals. If it could be introduced directly into the intestine in capsules, this would appear to be a preferable way of administering it.

The "comma-bacillus" of Koch grows best in media having a slightly alkaline reaction, and its development is retarded or prevented entirely by the presence of free acids in small amounts. A knowledge of this fact furnishes an indication for a method of treatment which has already been tested empirically and in favor of which there is considerable evidence, viz., the administration of the mineral acids in dilute solution, and especially of sulphuric acid. The prophylactic value of "sulphuric acid lemonade" seems to be established by the facts reported by Dr. R. G. Curtin, in the Philadelphia Medical Times (vol. iii., p. 649). A severe epidemic of cholera which had broken out in the insane department of the Philadelphia almshouse was apparently arrested within twelve hours by causing all of the inmates to drink freely a "lemonade" made with diluted sulphuric acid. The only new case after the commencement of this prophylactic treatment was a man who refused to drink the solution. Two new cases occurred on the second day after the acid drink had been discontinued, but upon resuming this the progress of the disease was again arrested.

SECTION II.

THE PREVENTION OF THE SPREAD OF CHOLERA.

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CHAPTER XXXIX.

RESPONSIBILITY OF NATIONS AND INTERNATIONAL NOTIFICATION.

Responsibility of Nations.—If we examine the history of past epidemics we find that almost without exception the appearance of cholera in any given locality may be traced to importation from its endemic habitat, and that in the exceptional instances where it has seemed impracticable to so trace it, the initial case has been in doubt, and the failure was due simply to lack of proper surveillance and inquiry. Modern views as to the prevention of the spread of epidemic disease in general, and cholera in particular, are governed by the belief that the infectious matter of such diseases is a material particulate poison, with the weight of evidence in favor of the opinion that the *materies morbi*, is a living thing or organism, capable of being transported in certain articles which for convenience sake we term *fomites*. The exclusion of these organisms, upon the one hand, or their destruction upon the other, is the respective basis of the principle of home quarantine and disinfection.

I shall proceed to discuss the methods of performing this service in detail, but before doing so let me refer to a broader topic—that of arresting cholera at its endemic center, which is the essence of prevention. A national government deriving "its just powers from the consent of the governed," during its existence as a government, must assume certain responsibilities, among which are those affecting the physical and pecuniary welfare of the people. A government must under the natural limitations of human rights, take the proper and necessary measures to protect its subjects against pestilence or famine, by such wise and prudent acts as the necessities of the time may seem to warrant. A failure so to do would subject such a government in the eyes of all civilized peoples to just condemnation, and as the safety of nations makes them mutually interdependent, whether they will it or not, so the safety of a particular nation is dependent upon the physical integrity of its several municipalities, as well as upon the physical integrity of its neighbors. This responsibility must be conceded by the political economist, and the governing motive then becomes a question of the relative weight of responsibilities which apparently conflict. Thus if we are debarred from commercial intercourse by reason of our fear of the importation of a contagious disease, that deprivation may result in famine of greater or less degree, and this as here stated in extreme terms, furnishes the key to the reason of the great and apparent irreconcilable differences of opinion as to the maintenance of quarantine. Modern nations have tacitly recognized these responsibilities and endeavored to meet them by "international conferences," rarely however with any view to mutual concession. At each "conference" thus far held, the commercial phase of the question has, although purposely kept in the background, seemed to be paramount;

and although there has been substantial agreement, first as to the responsibility of any nation having epidemic disease within its borders, that such disease should not be allowed through negligence to affect its neighbor; and second, as to the desirability of a synchronous united effort looking toward final eradication; yet the moment the details by which these desirable ends were to be attained were discussed, harmony was at an end, and so up to this time it has happened that each nation for itself assumes its own responsibilities toward its citizens, and allows its neighbor to adopt in turn such independent measures as in its judgment the occasion warrants. International law is silent upon the question, and although the usage of nations respecting invasion of neighboring territory by armed forces, or bandits; the enforced sale of provisions to starving troops—in a word, the general acts of necessity—are provided for, no provision or understanding has yet been arrived at concerning the responsibility of nations in the particular of the transmission of epidemic diseases. If, for instance, Germany or France should say to Great Britain, " You are in command of India, and in retaining that command you have failed to stamp out the cholera, which is at intervals destroying large numbers of our people, therefore we will proceed to India, and ourselves execute the necessary sanitary measures," that would amount to a declaration of war. The Indian and home government would rise up to resist invasion and the presence or absence of cholera would be lost sight of in the ensuing conflict. It is therefore clear that international public sentiment must be created to compel those nations owning cholera and yellow fever centers, to no longer afflict the globe by their apathy and indifference to the general welfare. Russia, as will be seen further on, set an example in relation to plague that is worthy of commendation and might profitably be followed by other nations.

It may be claimed that England cannot enforce in India those salutary and stringent regulations which she does at home in so admirable a manner, but to that it must be replied that the true doctrine of government implies the acceptance of such responsibility with the reins of administration.

Spain, in the destruction of the yellow fever centers of her West Indian possessions, has an easier task, owing to the smaller area of the infected territory, and the lesser engineering difficulties. It is stated, for instance, that the tideless stagnant water about the infected wharves and docks in the harbor of Havana might be regularly swept by tidal currents by cutting a short canal. And who can doubt that if the action of Russia in respect of the plague were imitated by Great Britain, Burmah and China as regards cholera; Spain, Brazil, Central America and Mexico, in respect of yellow fever, that those two diseases would speedily disappear from the earth. This is not a merely visionary idea, for it commends itself to human reason, and when once the doctrine of responsibility is conceded, and etiological facts are agreed upon, the necessary action can be enforced under penalty of commercial ostracism.

International Notification.—Within the last few years, most nations have adopted a system of " sanitary notification " for their own protection. As at present practiced, this notification emanates from the various consular officers. The consul of a country at a foreign city is required to notify the home government at stated times of the sanitary condition of the port or place, or " consular district " where he is stationed. Some countries, and among them the United States, require consular officers to inform the home government by telegraph of the outbreak of an epidemic, and when necessary or expedient, the progress of the epidemic is reported by telegraph daily. Under authority of Section 1752 of the United States Statutes, consular regulations have been issued which require the consul to notify the port of destination as well as the department, of the departure of a vessel from an infected port, or one carrying infected passengers or goods. For many years, in countries where certain contagious diseases are endemic, the British consulates have employed a physician, and the medical geography of the country thus obtained has been of great value not only to the home government but to other countries as well. The admirable papers in the "Chinese Customs Gazette" furnish an example of what may be done by intelligent medical men in connection with the consular service. The consuls of the United States are required to make a weekly report of the sanitary condition of their consular district upon the following form:

..................18

To the Honorable
THE SECRETARY OF STATE,
Washington, D. C., United States of America.

In compliance with the act of April 29, 1878, I have the honor to make the following report of contagious diseases, and deaths occurring therefrom, at this place, during the week ended ...., 18.., for the information of the Surgeon General of the Marine Hospital Service:

	CASES.	DEATHS	CASES TREATED IN HOSPITALS (Military, Civil and Private).	DEATHS IN HOSPITALS (Military, Civil and Private).
Cholera......................				
Yellow Fever...............				
Small-pox..................				
Typhus Fever (or Ship Fever)				
Enteric (or Typhoid) Fever..				
Scarlet Fever..............				
Diphtheria.................				
Plague.....................				
Totals.................				

Total deaths *from all causes* during the week reported,..........................
Population according to census of.................., 18...,......................
Present officially estimated population,..
Weekly mean of thermometer,.......... Weekly mean of barometer,..........
Prevailing diseases, (and other pertinent information,).........................
....

Very respectfully,

The law under which the foregoing report is required is the following section of the unrepealed portion of the Act of April 29, 1878, known as the National Quarantine Act:

"That whenever any infectious or contagious disease shall appear in any foreign port or country, and whenever any vessel shall leave any infected foreign port, or having on board goods or passengers coming from any place or district infected with cholera or yellow fever, shall leave any foreign port, bound for any port in the United States, the consular officer, or other representative of the United States at or nearest such foreign port, shall immediately give information thereof, and shall report the name, date of departure, and the port of destination in the United States; and the consular officers of the United States shall make weekly reports of the sanitary condition of the ports at which they are respectively stationed."

The enactment of this law is due perhaps in greater degree to the efforts of the late Surgeon-General John M. Woodworth than to those of any other one man outside of Congress. Four years before, in the report on the Cholera Epidemic of 1873, Doctor Woodworth wrote:

> What is needed is, that the National Government, through its consular officers, at least at each port of departure shall acquire the necessary information, and then promptly and intelligently furnish it to the ports and localities exposed. This is entirely aside from a national quarantine board, a national bureau of health, or other specific organization, concerning the present wisdom and expediency of which opinion at least is not unanimous. It is a simple utilization of already existing machinery on the part of the general government, for the acquisition of knowledge indispensable to the general welfare. Such knowledge cannot through its own agents be acquired by a State or by a municipality, yet upon such knowledge and action does the future immunity from Cholera of the country at large depend.
>
> A circular letter from the President, through the Department of State, instructing consular officers to place themselves in communication with the health authorities of their respective localities; to advise promptly, by cable if necessary, of the outbreak of cholera (or other epidemic disease) at their ports or any section in communication therewith, to inspect all vessels clearing for United States ports with reference to the original and intermediate as well as to the final points of departure of emigrants thereon; and to report always by cable the sailing and destination of any such vessel, carrying infected or suspected passengers or goods —this should be the first step.
>
> And the next would be equally simple: A medical officer, selected for his good judgment and attainments in sanitary science, should collect and digest the information thus obtained, and transmit to the threatened ports, as well as through the public press, the note of warning. Thus advised, the threatened community would have ample time for preparation, and the publicity given to the warning would be the most efficient means of insuring proper precautionary measures.

At the International Sanitary Conference of Washington, much stress appears to have been laid upon the bill of health issued to vessels, and after a long discussion of that and kindred topics, the following form of a bill of health for international use was adopted without dissent:

INTERNATIONAL BILL OF HEALTH.

I, ... (the person charged to deliver the bill), at the port of .... do hereby state that the vessel hereinafter named clears from this port under the following circumstances:

Name of vessel................. Nature (vessel of war, ship, schooner, etc.).
Tonnage ....; Apartments for passengers; No. ......; Guns ......;
Destination ....; Where last from ....;
Name of medical officer (if any).............; Name of captain ....;
Total number of passengers: 1st cabin, ...; 2d cabin, ...; steerage, ...;
Total number of crew, ...; Cargo, ...

Vessel.—Sanitary condition of vessel (before and after reception of cargo, with note of any decayed wood).

1. Note disinfection of vessel ....
2. Sanitary condition of cargo ....
3. Sanitary condition of crew ....
4. Sanitary condition of passengers ....
5. Sanitary condition of clothing, food, water, air, space and ventilation......

Port.—1. Sanitary condition of port and adjacent country ....

a. Prevailing diseases (if any)...............

b. Number of cases of and deaths from yellow fever, Asiatic cholera, plague, small-pox or typhus fever during the week preceding.

Number of cases of		*Number of deaths from*	
Yellow fever.................	—	Yellow fever.................	—
Asiatic cholera................	—	Asiatic cholera................	—
Plague......................	—	Plague......................	—
Small-pox...................	—	Small-pox...................	—
Typhus fever................	—	Typhus fever................	—

c. Population according to the last census ......

d. Total deaths from all causes during the preceding month ......

3. Any circumstances affecting the public health existing in the port of departure to be here stated..............................

I certify that the foregoing statements are made by ...., who has personally inspected said vessel; that I am satisfied that the said statements are correct, and I do further certify that the said vessel leaves this port bound for .... in ....

In witness whereof I have hereunto set my hand and the seal of office, at the port of ...., this ...... day of ...., 188 , ... o'clock.

[SEAL.] [Signature.]

But it is found in practice that the bills of health are in some cases untrustworthy and are not to be depended upon at our ports, and the quarantine officer must rather act upon information otherwise received by him concerning the sanitary state of the port of departure. Thus while this is being written yellow fever is prevalent in epidemic form on the isthmus of Panama, and yet no bill of health from Panama or Aspinwall gives a statement of the existence of such an epidemic. This does not imply that the consul is neglectful, but he is obliged to accept the statement of the duly constituted health authorities of the country, and a refusal so to do would result in the withdrawal of his exequatur. In such cases he can only notify his government. At the Sanitary Conference of Washington, no representative was willing to agree that the "certifying authority" of the port of departure should be other than the local authority, and as in the case of Panama, and perhaps instances nearer home, the fear of being placed at a commercial disadvantage has operated as a powerful motive for concealment of contagious disease.

The Conference of Washington went much further in the matter of perfecting a plan for International notification than any of the preceding conferences. Resolutions III. and IV. adopted by the Conference are as follow:

III. In the interest of the public health, the sanitary authorities of the countries represented in this conference are authorized to communicate directly with each other in order to keep themselves informed of all important facts which may come to their knowledge; but nothing herein contained shall relieve them from the duty of furnishing at the same time to consuls in their respective jurisdictions the information they are required to give them.

IV. A centralized international system of sanitary notification being deemed indispensable to the successful carrying out of measures for preventing the introduction of disease, it is advisable to create international organizations to be charged with the duty of collecting information in regard to the outbreak, spread and disappearance of cholera, pest, yellow fevers, etc., and of conveying such information to the parties interested.

The representatives of the United States, at the conference, voted against the latter of these resolutions, but it was adopted by a vote of 13 to 3.

The plan by which it was proposed to carry out resolution IV. of the conference is as follows:

ANNEX I.

The draft of a convention mentioned in Resolution IV. is as follows:

Article I. There shall be established in Vienna and Havana a permanent International Sanitary Agency of Notification. The respective governments shall agree among themselves as to the formation of those agencies.

Art. II. It will be the duty of the agency at Vienna to gather sanitary information from Europe, Asia and Africa. The agency at Havana will extend its sphere of action to the American Continent and the islands belonging geographically thereto. This system to be subject to such modifications as may be rendered necessary by the state of telegraphic communication.

Art. III. The contracting governments shall have the right to establish, if necessary, a third agency in Asia.

Art. IV. The governments agreeing to this system of notification will send their sanitary reports to that agency in whose jurisdiction it is. Every agency shall send its notifications to those governments sending sanitary bulletins. The different agencies will exchange the information they receive among themselves in order that it may be made known to the respective countries belonging to the jurisdiction of each.

Art. V. There shall be no exceptions to this system, save in cases of extreme emergency. In such cases, however, a government may enter into communication with an agency to whose jurisdiction it does not belong.

Art. VI. In cases of doubt as to correctness of the bulletins received, the agency is authorized to enter into communication with the respective governments, who will be obliged to furnish as soon as possible the information asked.

Art. VII. In those countries where international sanitary boards exist the agencies shall establish communication with them.

Art. VIII. In those countries which have not a perfect sanitary organization, or which have not adopted the conclusions of this conference, the consuls of the contracting powers shall meet in an International Sanitary Council in order to give to the said agencies the information which cannot be obtained from the local authorities.

Art. IX. The Governments of Spain and Austria-Hungary shall fix the annual budget of expenses, which they will submit to the participating governments.

Art. X. The division of expenses between the different governments shall be as follows: Half of the expense will be divided in proportion to the number of population, and the other half in proportion to the amount of tonnage of the merchant marine combined with the commercial maritime value of every country.

Art. XI. The Governments of Spain and Austria-Hungary shall submit at the end of every fiscal year the final accounts to every one of the interested governments.

Art. XII. The present convention is concluded for the space of ten years. Any government, however, is at liberty to renounce the Convention after three years. The right is reserved to make such changes as any one of the governments taking part shall designate.

But none of the governments sending representatives to the Conference have agreed to the rules and regulations there suggested.

After all there is, perhaps, no better plan than that adopted by Great Britain and the United States, namely, when information is wanted to call upon its own officers to furnish it, and then to publish the result. Under existing appropriation acts, a medical officer can be attached to any U. S. Consulate whenever believed to be necessary or essential.

CHAPTER XL.

MEDICAL INSPECTION, INCLUDING THE THEORY AND PRACTICE OF QUARANTINE.

I. The Theory of Quarantine.—No one who has studied without preconceived ideas or prejudice can fail to conclude that if the germs of cholera were excluded from a country. that country would certainly escape an epidemic. It is for the purpose of assisting in the work of exclusion of disease germs that quarantines are now maintained, and medical inspections instituted. It is true that the history of quarantine shows that its beginning was purely empirical, for the city in the sea that had the first lazaretto was forced thereto by necessity. Venice was the great commercial entrepot of the Mediterranean; her sails whitened the horizon of every known harbor, and her returned vessels crowded her own docks. Her great commerce made a flourishing carrying trade, and stimulated travel, but at the same time brought fomites to her households. There were repeated epidemics the origin of which was traced either to the returned merchants, their sailors or their ships. Hence those wise Adriatic shop-keepers who valued life even above shekels, concluded to place restrictions upon the carrying trade, so that by detention they might conclude whether or not a particular vessel was infected, before allowing her entry into the port. They fixed upon the period of forty days as the time necessary for such detention: hence the term quarantine. The time, as we now believe, was unnecessarily long; the consequent detention cruel and hazardous, but for many years it was rigidly maintained, and although the time of detention has been everywhere reduced, it is still tedious and productive of much hardship at many ports. The dangers of this excessive caution, the fear of commercial losses, and their reflex influence upon medical teachings have operated as powerful agents against the entire system. Thus there have appeared violent invectives against the practice of quarantine from many who should have been counted among its suporters.

Professor Stillé,[1] who has examined this question with that candor and regard for worthy opponents that has always been characteristic of him says: "There is urged against the enforcement of a rigid quarantine by land or sea the singular argument that it has not always excluded the disease. A more logical inference would seem to be that since it succeeded, not completely, but yet partially, its inefficiency should be charged to its imperfect execution; or even granting that the absolute exclusion of cholera is impracticable in every instance, including cases of choleraic diarrhœa, contaminated clothing, and merchandise, does it follow that the transit of men and things should be unimpeded? As well might it be maintained that because one or more houses cannot escape destruction by fire, therefore no effort should be made to save the remainder of a threatened city; as well might it be argued that because some men must be killed in battle no precautions should therefore be used to preserve the rest of the army; as well abstain from all local sanitation intended to mitigate the ravages of the disease because some victims it will surely have. This is taking counsel from despair—is a stupid fatalism which one might imagine to have been imported with the disease from the East. . . .

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[1] Loc citat., p. 755–56.

"Probably no sanitary cordon nor any quarantine will invariably and completely exclude cholera, since it is transmissible by living men, and by water and by fomites of various descriptions, and worst of all by men who neither exhibit its characteristic symptoms nor are conscious of the poison which they conceal and disseminate. But, as has already been urged, it is no argument against preventive measures that they are not absolutely perfect in their efficiency. If they sometimes succeed in arresting the progress of cholera, and if they always when honestly executed lessen the number of channels through which the infection can be conveyed, and thereby reduce to a minimum its fatal effects, they ought to be maintained and perfected and not decried or abolished. It is difficult to characterize that state of mind which concludes against the use of a salutary measure because its efficiency is not absolute, the more so when it is admitted that its inefficiency is not intrinsic but due to negligent and fraudulent administration."

It would fill more pages in this volume than are at the writer's disposal to give brief details or perhaps even to simply enumerate all the instances where the observance of strict quarantine has apparently resulted in the escape from an epidemic elsewhere prevailing. The writer having due regard for the argument that these instances are but examples of the *post hoc ergo propter hoc* fallacy, must conclude that the germ theory itself is the best possible argument in favor of the effectivness of rigid quarantine. Even if we adopt the theory that the poison is inorganic, the evidence of centuries of observation proves it to be transportable; being transportable it must be possible to prevent its transportation by the exclusion of the vehicles of transportation—*fomites*. From this conclusion there seems no escape; and it is the writer's belief that had the Indo-Javanese pilgrims been quarantined by the Egyptian authorities, the calamitous epidemic of cholera of 1883 would not have darkened the page of her history.

So long as nations neither stamp out disease within their territories nor see to it that all ships are clean and sail from clean ports, just so long it will be necessary to maintain a quarantine of some sort, and it is probable that inspection stations can never be dispensed with, but their use may in coming time be reversed, that is for the inspection of *outgoing* ships.

The recent experience of Europe has not tended to settle the question as to the efficacy of quarantine, although the principle still remains as quoted from Professor Stillé, that where there has been a failure it is due to the laxity of the quarantine. Tommasi-Crudeli of Milan, writing after the cessation of the recent epidemic in Italy says: "Sea-quarantines offer stronger guarantees than land quarantines, but may, however, prove deficient for three reasons: First, because the duration of the quarantine in proportion to the period of incubation is insufficient; second, because during quarantine the disinfection of really infected objects is impracticable. It is not sufficient to leave infected boxes of linen half exposed to a chloridic atmosphere; the essential is that during quarantine there be thorough and vigorous disinfection; third, because, notwithstanding, all governmental regulations, even sea quarantines, are easy to violate. He proceeds: "At Malta, in 1865, after the appearance of cholera in Alexandria, Egypt, the Government ordered a rigorous quarantine, but it was violated and the epidemic broke out violently. Too many interests prompt its violation, and it is seldom that people, as did the Sicilians, unite in silencing such interests. In Sicily, in 1865, the whole population advocated a quarantine of seven days for vessels arriving from non-infected ports, and of absolute non-intercourse with infected countries, and the island was thus guarded until the insurrection of September, 1866. The epidemic appeared the very day on which troops sent from Naples, where cholera was raging, arrived at Palermo. The epidemic spread rapidly, and the incident shows that *when sustained by the population, sea quarantine is efficacious*."[1] The Honorable Philip Carroll, U. S. Consul at Palermo, writing to Honorable William Hunter, Second Assistant Secretary of State, under date of February 9, 1885, says: "With reference to the non-appearance of cholera in Palermo, during the recent epidemic, in places almost conterminous thereto, the general belief here is that the immunity was due to the effective and rigorous quarantine which was at once established and maintained until some time after it was suspended in other places and ever vestige of the disease had disappeared. In support of this belief, they quote the epidemics of 1865 and 1873, when the same vigorous measures were adopted and maintained, with the same immunity from the disease, whereas in 1866 the insurrectionists broke the quarantine, when cholera immediately broke out and made havoc among its inhabitants. From personal observation I am quite sure that the sanitary condition of the city had little or nothing to do with its escape from the recent contagion; on the contrary, there were many circumstances and conditions which in this respect were favorable to an outbreak of the disease."

The recent sanitary history of Sicily cannot fail to teach a salutary lesson to those preaching the inefficacy of sea quarantine. The quarantines of Italy, on the contrary, were inefficient. Dr. Mosso[2] states: "When I asked Dr. Koch what he thought of the quarantines in operation in Italy, he replied to me: 'I am convinced they are worth nothing; they are half measures without real results.'"

THE PRACTICE OF QUARANTINE.

A. By Sea.—The practice of quarantine is without uniformity, scarcely any two countries conforming to the same regulations; and, as pointed out by Dr. John S. Billings, U. S. A., "Theoretically (quarantines) as a rule err on the side of excessive requirement; practically the error is the other way. Neither in America nor in Europe can one draw reliable conclusions as to what is actually done at a quarantine establishment from its printed regulations." (Transac. International Medical Congress, Vol., IV. page 419, London 1881.) It is natural that diversity of climate and differences of season should modify the practice of quarantine at particular ports, but there should be no laxity of administration at any time or anywhere. The *medical inspection* which is the only method of ascertaining the facts regarding the sanitary condition of passengers, cargo, crew and ship, should be everywhere carried on in the same way. The period of detention may reasonably vary with port and season, but the inspection should be always the same.

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[1] The italics are mine.—J. B. H.

[2] Mosso, Le Precauzione contre il Colera e le quarantene. Reprint from Nuova Antologia, vol. xlvii., fasc. xviii. 15 Settembre, 1884.

Carelessness in making such inspections is a crime and should be so considered. Efficiency depends upon the *honesty*, *faithfulness* and *patriotism* of the inspector. No man should be selected for this great responsibility who does not combine with the necessary technical knowledge these three characteristics.

The following, revised from an article by the writer,[1] gives an account of the details of quarantine management:

A quarantine station usually consists in a hospital for the sick (lazaretto, so named from the isolation of St. Lazarus on account of leprosy, *mal de Saint Lazare*); a boat, usually a steam vessel, to carry the boarding officer and supplies for the station, if there be any sick found on board the vessel coming into port, a separate boat or the ship's boat should take them to the lazaretto; and quarters for attendants. On arrival of a vessel at the quarantine, she is boarded by an inspecting officer, her bill of health examined, the crew and passengers mustered, the vessel itself inspected in every part to determine whether it be clean or foul. At this day, the bill of health is not accepted as *prima facie* evidence of the sanitary condition of the vessel, but is only corroborative. Even if it be stated thereon that the port from which the vessel last sailed was free from infectious disease, the inspector trusts to his own inspection of the vessel and examination of the persons on board and the cargo, together with his knowledge of the sanitary condition of the port of departure to determine whether or not the vessel should be detained in quarantine. If, however, the vessel is from an infected port, and the period of incubation of the disease has not elapsed, the vessel is detained in quarantine until the expiration of that time, whether there be sickness on board or not. If there be found contagious sickness, the sick are removed to the hospital, the bedding and other articles in their state-rooms or berths removed and destroyed, and the place thoroughly fumigated with the fumes of burning sulphur. In case the vessel is discovered to be foul and in an unsanitary condition, whether there is sickness on board or not, the vessel is detained in quarantine for the purpose of cleansing and fumigation, the cargo is removed to a warehouse, or to open lighters, the bilge water pumped out and all parts of the vessel fumigated. The hold of an infected vessel should be thoroughly washed out before fumigation with solution of the sulphate of copper. The sulphate of iron is cheaper and nearly as efficacious. Corrosive sublimate solution may also be employed. Whenever necessary, the wood-work should be repainted.

For the treatment of the cargo as well as the vessel much yet remains to bring the practice to a level with the advanced state of collateral sciences. As shown by Dr. Joseph Holt of New Orleans, we are still pursuing the practice of a past age in the lack of improved machinery. An invention has recently come into use for the disinfection of rags which makes it possible to disinfect them in a bale. The fumes of burning sulphur, are driven into the bale through hollow, perforated screws. Superheated steam may also be used, and is in fact easier of application.

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[1] Cyclopædia of Political Science, Political Economy and Political History of the United States, edited by John S. Lalor, Chicago, 1883.

B. By land.—Land quarantine is that form of quarantine which has furnished the opponents of the system with their most effective arguments. If rigorously carried out, it is denounced as cruel and barbarous; if loosely enforced, it is certainly ineffective. The weight of medical opinion at this day is theoretically against land quarantines,[1] but practically almost every country establishes an inspection system on its frontier as soon as the introduction of an epidemic is threatened. In the United States "shotgun" quarantines always follow the failure of a State or the Government to establish a proper quarantine, and as one of the elements of land quarantine, and as well as a means of allaying excitement and preventing panic, *cordons sanitaire* are very useful, as was proved during the yellow fever epidemic of 1882 in Texas. Sparsely settled countries show the usefulness of the *cordon sanitaire* to its best advantage; indeed the system is considered impracticable if not impossible to carry out where large cities are concerned. This, however, is fallacious; the land quarantine is difficult to carry out, but not by any means impossible. A land quarantine is simply medical inspection of travelers, their baggage, the vehicles of transportation and the freight carried thereon, and the *cordon sanitaire* simply the local police. This duty may be effectively performed by troops or by carefully picked men from civil life. The plan followed in Russia as a means of stamping out the plague will appear from the following account:

"The Oriental plague made its appearance in the district above Astrakhan, in Russia, about the middle of November, 1878. It prevailed along the river Volga, and upon its islands. The center of the malady was in the village of Wetljankaja, with a population of some seventeen hundred inhabitants. The Governor of Astrakhan telegraphed to the Minister of the Interior the report of the medical supervisor of the Cossack forces in the district of Astrakhan, Dr. Depner. A few cases had appeared in the previous year, but the disease had not become epidemic until November, 1878. From the 27th of November to the 9th of December, out of one hundred sick in Wetljankaja forty-three died; and in less than a month two hundred and seventy-three persons died of the dis-

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[1] The following may prove of interest in this connection:

On the 1st of July, 1884, the Minister of Commerce appointed the following named persons to serve as a cholera commission to consider the measures best adapted to restrain the ravages of the epidemic at that time existing at Toulon and Marseilles. The commission was composed of MM. Brouardel, chairman, Pasteur, Peter, Proust, Legouest, Rochard, Gallard, Vallin, and Nicolas, director of internal commerce. The commission presented its report to the Academy of Medicine, in order to obtain the approval of that body, before submitting it to the Minister of Commerce. The conclusions of this report, which were adopted by the Academy, were as follows:[1]

1. Land quarantines, whatever be the form under which they are established, are impracticable in France. 2. The methods of disinfection imposed upon travelers and their baggage in the railway stations are inefficacious and illusory. 3. Posts of medical surveillance might be established in the larger stations along the lines of railway in order to render assistance to those attacked with cholera, and to isolate them from the other travelers. 4. The efficacious measures of preservation are those which each one ought to take for himself and his house.

The duty of the municipal authorities is to see that the instructions in regard to isolation of the sick, to disinfection of linen, clothes, apartments, etc., are rigorously enforced, and that the precautions of private and general hygiene are executed in all their rigor.—E. C. W.

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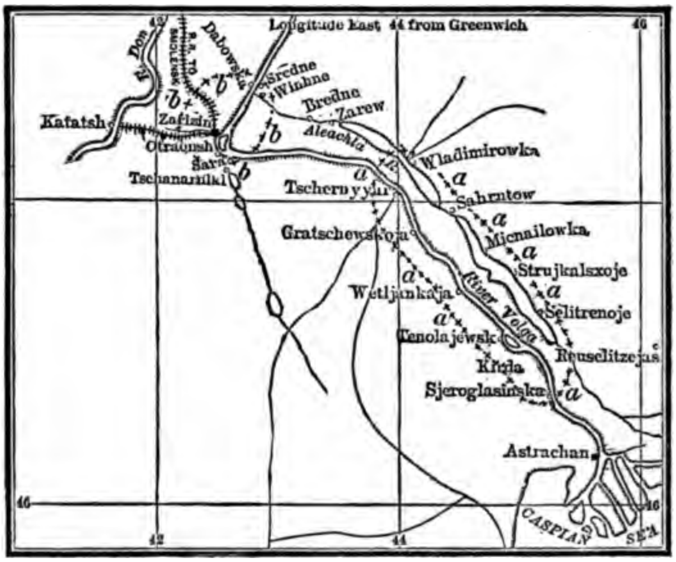
[1] Brouardel; Épidémie du Choléra à Toulon et à Marseilles, Paris. J. B. Baillière et Fils, 1884.

ease. It then spread from Wetljankaja to the surrounding villages, and was declared epidemic. 'Dr. Koch and six army surgeons became victims to the epidemic, the priest died, the Cossacks who attended the sick or removed the dead died; almost all died who in any way came in contact with the sick or dead.' Dr. Depner then arrived at the conclusion that the only means for suppressing the disease was quarantining; and on the 11th of December, Dr. Depner, with Colonel Preibanow, instituted measures. He could not prosecute further observations, however, for he himself fell sick with the plague. These facts being telegraphed to the Emperor of Russia, the Imperial Committee of Ministers was convened, and the following rules were adopted, which received the imperial sanction:

"1. (*a.*) The inhabitants of the colony of Wetljankaja shall be transferred and distributed as shall seem best after a careful examination of the local requirements, the limit of the quarantine not to be overstepped.



"(*b.*) The appraisement of the movable and immovable property destroyed by fire, as likewise the fixing of the indemnities to be paid to the owners, shall be reserved for a special commission, under the presidency of the Governor of Astrakhan, with the participation of members of the Cossack administration and the Ministry of the Finances, the Ministry of the Domains, and the Ministry of the Interior, according to regulations which shall be prepared on the spot by the aforesaid commission.

"(*c.*) This commission shall be charged with the execution of all the measures that may be necessary for the destruction by fire of the colony of Wetljankaja, as likewise of all measures necessary to supply the population transferred from that colony with food, underclothing, and warm garments; to provide for the treatment of the sick, etc.

"2. That the acting Minister of the Interior may be authorized to extend the measures referred to concerning the colony of Wetljankaja to other villages, as well as to isolated buildings everywhere, to such extent as shall be deemed indispensable.

"3. That three regiments of Cossacks may be immediately placed at the disposal of the civil administration for the quarantine service.

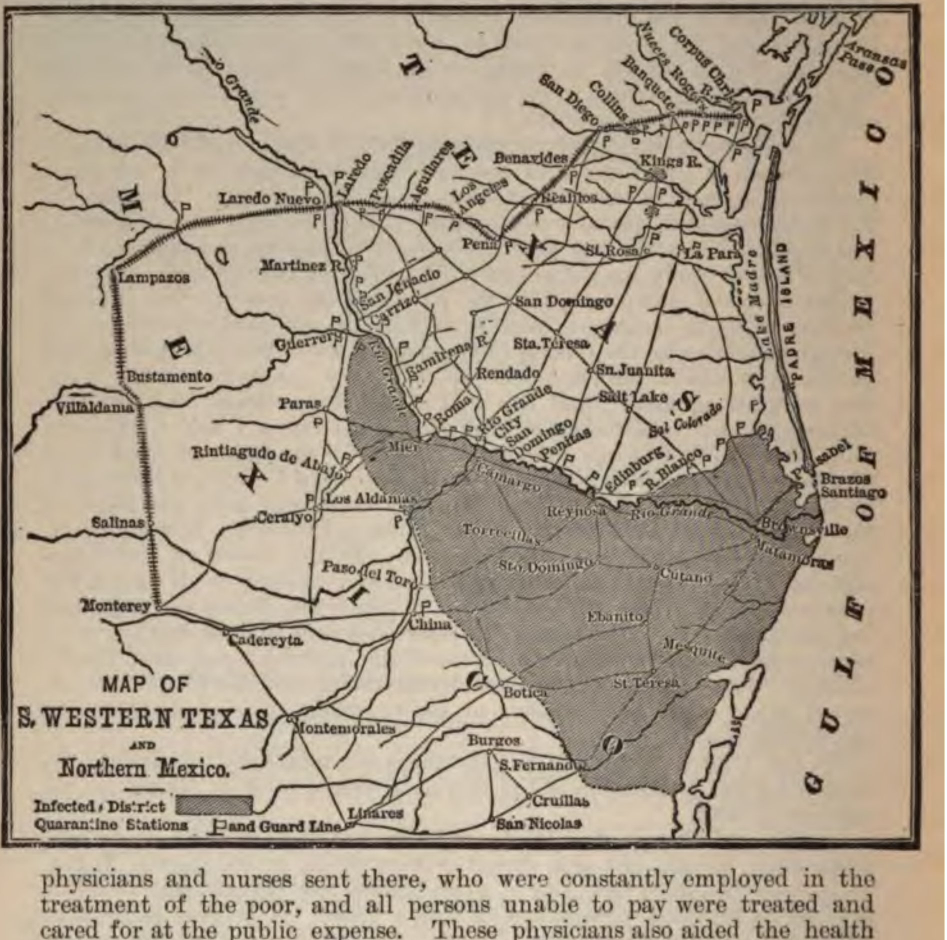
"4. That all outlays necessary for the execution of the measures above referred to, and to meet the expenses of all measures that may be required by the present epidemic, may be charged to the account of the imperial treasury."

It was the unanimous conclusion that "the plan of burning the colony of Wetljankaja (the center of the infection) is proposed after a thorough examination of the question, and from a conviction of the indispensable necessity of so radical a measure for the extirpation of the disease in the locality where it first appeared—the committee having subsequently heard the opinion of the physicians present, both with regard to the measure in question, and in general in relation to the means which have been shown by science and experience to be best adapted to put a stop to an epidemic, and to prevent it from spreading."

In addition to the irregular troops mentioned above, bodies of infantry were placed at the disposal of the civil establishments, and unlimited credit was opened to meet all expenses from the treasury. His Majesty the Emperor sent a special commissioner plenipotentiary. A commission was appointed to act in the matter, composed of medical specialists, whose duty it was to study the subject of the progress of the epidemic, and the proper means of stamping it out, and purifying the localities then infected or those likely to become so; and in view of the impression produced in foreign countries by the reports of the plague, they should furnish to this government reliable information concerning the epidemic, and the measures adopted against it; and the instructions were carried out as above outlined, under the direction of Aide-de-Camp General Count Loris-Melikoff, who was sent to the infected locality with the rights and privileges of a temporary governor-general. On the arrival of Count Loris-Melikoff, in March, 1879, an international sanitary council was held, composed of the most distinguished sanitarians of Europe, Professors Hirsch, Besiadetsky, Cabiadis, Petrisco and Eichwald. By the advice of the International Council, a general sanitary cordon was established all round the province of Astrakhan, with the object of protecting Russia and neighboring countries of the empire, and Professor Eichwald advised that the sanitary cordon should be maintained around the infected region until the 2d of May. These measures were entirely successful, and the plague did not spread to any other place outside of the originally infected district, nor has it reappeared.

In the United States a land quarantine was established under my direction for the prevention of the spread of yellow fever in Texas in the summer of 1882.

A serious epidemic of yellow fever broke out in Bagdad, Tampico, and Matamoros, Mexico, and soon spread to Brownsville, in the State of Texas. There were in a short time, out of a city of some 5,000 inhabitants, between five and six hundred persons sick of yellow fever. A general panic prevailed throughout southwestern Texas, and refugees were leaving that part of the State in great numbers, as it was believed the infection would rapidly and certainly extend to the surrounding country. Under these circumstances, an appropriation of $100,000 having been placed at the disposal of the Treasury Department to prevent the spread of epidemics, by the President, the Governor of the State of Texas applied to the Secretary of the Treasury for assistance from the general government; and, as the exact area of the infected region was undetermined, at my suggestion a cordon was immediately established from Corpus Christi, on the Gulf, to Laredo, on the Rio Grande, along the line of the Texas and Mexican Railway. No person was allowed to pass this cordon until after ten days' detention at some one of the quarantine stations (represented by flags upon the accompanying map), that length of time being considered necessary to determine whether or not the particular person would be attacked with yellow fever. Baggage was not allowed to cross the line upon any pretext. A hospital was established in the city of Brownsville, a dispensary opened, and experienced physicians and nurses sent there, who were constantly employed in the treatment of the poor, and all persons unable to pay were treated and cared for at the public expense. These physicians also aided the health authorities of the city in carrying out sanitary measures, including the fumigation of houses.


MAP OF
S. WESTERN TEXAS
AND
Northern Mexico.

As soon as practicable after opening the hospital, an inner protective cordon was established, thirty miles from Brownsville, the original cordon having been one hundred and eighty miles distant. Perfect liberty was allowed to the inhabitants of the infected city to leave at any time, and they were encouraged to scatter in camps; but they were not allowed to cross the cordon until after personal detention of ten days, and fumigation of their wearing apparel; and, as in the case of the outer cordon, the crossing of baggage was positively interdicted. It was intended to remove the upper cordon between Laredo and Corpus Christi within ten days after the formation of the inner one, which extended from Santa Maria, on the Rio Grande, to the mouth of the Sol Colorado; but it was retained for several days longer, as certain of the refugees who had left Brownsville prior to the establishment of the Colorado cordon developed yellow fever. They were quarantined in the camps where they were, and their infected bedding and baggage burned. The fever continued its spread and devastation on the Mexican side of the Rio Grande, and Reynosa, Camargo, Mier and Guerrero successively became infected. It was then found necessary to protect the entire line of the Rio Grande, from Laredo to Santa Maria, a distance of nearly five hundred miles, by a cordon. The upper cordon, from Laredo to Corpus Christi, was then removed, and the line reëstablished along the Rio Grande, and the crossing-places carefully guarded; and, although the towns in Mexico were greatly devastated by the disease, there was no extension of it in Texas; on the contrary, it was confined to the limited district where it first appeared, bounded by the Colorado cordon on the one hand and the Gulf of Mexico upon the other. The Mexicans, seeing the good effects of the sanitary cordon in the United States, followed the example, and established quarantine stations in Mexico, guarding against the infected towns; and there, too, the quarantine proved successful, and arrested the spread of the disease. The Governor, the State Health Officer, and the State officers generally, assisted the work of the government by all the means at their command.

In July of the same year a few cases of yellow fever appeared in Pensacola, Fla., and later the disease became epidemic, and, as in Texas, a general panic prevailed. The villages and towns surrounding Pensacola established a rigid quarantine against it, no person from that city being allowed to enter except after proper detention and fumigation. In consequence of this, the towns that had thus protected themselves by the quarantine were not infected, and the disease did not spread, while the places adjoining that did not quarantine against Pensacola had the fever. The Government also protected its navy-yard, which joins the city of Pensacola, by means of a sanitary cordon and non-intercourse with the city during the prevalence of the epidemic, and it, too, escaped.[1]

It is as unfair and unscientific to denounce land quarantines because the majority of them have been inefficient as it is to denounce sea quarantines on similar grounds, but this in fact seems to be the real reason for the opposition. Professor Tommasi-Crudeli, in a recent article, says: "How proceed, for example, in circumstances like the present, when cholera is on the European continent at Toulon and Marseilles? Think you that if a panicky terror seized the population of the stricken places, especially of our Italian colonies, as it has, in fact, it would be possible to forbid the return of the fugitives to Italy by the issuance of sanitary ordinances? If we barred the 'Twenty-mile road,' they would turn to the Cenise pass; if we blockaded the latter they would force the Gothard way; could we close every railroad line and every Alpine wheel route, they would improvise a hundred footpaths through the mountains to find a way to return home. We see something similar in contraband frontier traffic. Two revenue cordons, one Italian and one French, have been organized and maintained for united efforts to repress contrabandage and for the protection of material interests jeopardized by it, but in spite of them Italian bands continually enter France, and French bands enter Italy."

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[1] From an article by the writer in Appleton's Annual Cyclopædia, 1883, pp. 291–294.

This argument would seem to indicate that the learned professor would abolish the revenue laws because of the inefficient manner in which they are enforced. A land quarantine when properly conducted is not at the present time an impassable barrier. At the cordon, refugees are simply detained for inspection and to await the period of incubation of the disease; with proper refuge stations along the line, there is no difficulty in providing suitable accommodations. The hospital tents used by the United States can be made entirely comfortable. At the last meeting of the "Mississippi Valley Sanitary Council," held at New Orleans, March 11th, 1885, it was agreed that sleeping-cars should not be allowed to pass inspection stations when coming from any infected place, and such station should be established at a point not less than fifty nor more than seventy-five miles from the infected place. At this station the well passengers should be transferred, and those suffering from real or suspected contagious disease shall be detained at a hospital. In regard to baggage, it is provided that none shall leave an infected city without thorough disinfection by means of bichloride of mercury. This system of inspection is substantially that adopted by Holland so satisfactorily during the recent epidemic. The Dutch required that all persons passing the line should leave their address, and all soiled clothing was left behind to be disinfected.

C. In Foreign Ports.—In the subdivision on international notification the general necessity of having a medical attaché at each consular district was mentioned in connection with duty in regard to bills of health, etc.; but when an actual epidemic appears in any district having direct or indirect commerce with the United States, the necessity for the employment of such an officer becomes more imperative, because the responsibility is then placed upon him of preventing so far as he may be able, the embarkation of sick emigrants, or of infected baggage or merchandise. The medical inspection of each passenger, and tracing up his record, and noting the character and condition of the baggage, was the somewhat onerous duty the Government placed upon its medical inspectors abroad during the recent outbreak of cholera in Europe. At every European port whence vessels departed for the United States this system was faithfully carried out. One steamship line protested that their surgeon made an inspection of emigrants and their baggage, and that there was great and unnecessary delay by their being obliged to undergo the special rigid inspection; and in many cases they were sent back by the inspector for disinfection, but the responsibility imposed upon the Government was too deeply felt to allow any relaxation of the foreign inspections, until the subsidence and disappearance of the epidemic, and during the past year not a single case of cholera was received at any quarantine station of the United States.

CHAPTER XLI.

MUNICIPAL MEASURES AND PERSONAL PROPHYLAXIS.

The Municipal Measures to be adopted for the prevention of cholera, in addition to those of quarantine already described, consist of all those measures which favor cleanliness and thus counteract a lodgment of the disease germs, and those necessary should the disease nevertheless be imported. The proper municipal health authority should inform the public—

First, That there is no occasion for alarm if the regulations are complied with; and,

Second, The regulations should be published in such manner that every householder may receive notification of the things required of him. With the carrying out of the regulations, the police and health departments of cities should be jointly charged. The city, for convenience, should be divided into sanitary districts and the sanitary officer held responsible for the condition of each district. A special hospital, or hospitals, should be provided, and, in connection therewith a public laundry established. The most careful cleanliness should be everywhere rigidly enforced, all dark and damp places thoroughly disinfected and drains and sewers systematically flushed, and house inspection should be made often enough by the sanitary inspector to insure that their condition does not become worse from neglect. Congregations of the people in times of epidemic should be avoided. Great crowds should not be allowed to form in any portion of the city. Should cholera break out in any house, the sick should be removed, if possible, to the special hospital, the house itself thoroughly disinfected, all the interior hangings, carpets and the like removed for disinfection by superheated steam. Physicians, and all other persons having knowledge of a case of cholera, should, under penalty, be required to immediately inform the nearest policeman, through whom the fact would be made known in the speediest manner to the proper authority. Special hospitals for cholera patients were found to be of great advantage during the recent outbreak of cholera in Europe, and although, as at Marseilles, the mortality in them seemed a little higher than in the city outside, yet it is doubtless due to the fact of the advanced stage of the disease when the patients are admitted, for mild cases rarely find their way to the hospital no matter how stringent the regulation. In Boston, in the epidemic of 1849, a cholera hospital was improvised, and patients were sent there by the district inspectors. The city physician was placed in charge, and the hospital was considered to have been a valuable adjunct to the means of prevention of the spread of the disease.

Of the public laundries, there is a baseless fear that they may become centers for the propagation of the disease, but when it is considered that the laundry, if rightly managed, is constantly under the eye of an inspector, who is responsible for carrying out the sanitary regulations, it is at once seen that such fear is without reason. Tommasi-Crudeli, who was the director of the Public Health in Palermo in 1866, says that in managing the municipal laundry "the carts made the rounds and collected all the infected clothing, which as soon as brought was immersed in a solution of chloride of lime; we laundried for the poor gratis, but could only manage the washing for public institutions, as the citizens of the town, fearing contagion, refused to send their clothing to us. The result was that of my employees and of my laundresses not one took cholera, while eleven laundresses washing in the usual manner died."

The instructions of the French Minister of Commerce of July, 1884, were full and explicit upon the method of disposal of infected linen and clothing, and preventive measures generally.

Body linen soiled by dejections, before leaving the bedchamber, were required to be plunged in a solution of the "liqueur bleu"[1] for a period of half an hour, then plunged in boiling water before undergoing the ordinary washing. All clothing suitable for washing was required to be treated as above, but clothing that could not be washed was submitted to the fumes of burning sulphur, burning not less than 30 grams of flowers of sulphur for each cubic foot of air space in the cabinet or box where the clothing was suspended, having previously rendered the air humid. But where the clothing was much soiled, by dejections or vomit, it was burned.

As to the bedchambers of the persons sick of cholera, the carpet was immediately washed by the aid of a brush with the "solution blue" or with chloride of lime, and the walls also treated in the same way. The room was also required to be fumigated with the fumes of burning sulphur as soon as the patients were removed. Twice daily the water-closets or chamber vessels were washed with the solution blue, followed by a saturated solution of the chloride of lime. The infected house was placed in charge of a sanitary inspector and the regulations strictly enforced, the house itself being quarantined for twenty-four hours from the disappearance of the case and the completion of the fumigation. Disinfection materials were provided free and distributed by the police, and no patient with cholera was allowed to remain at a hotel, but was sent immediately to the special hospital in an ambulance kept especially for these cases. The disinfecting fluid recommended for general use in immediately disinfecting the vomited matters and the dejections was a solution of 50 grams each, in a litre of water, of chloride of zinc, sulphate of copper and sulphate of zinc.

The proper sanitary officer should cause regular and frequent examinations to be made of the drinking water of the city, and any householder depending upon a well or cistern for water supply should have the privilege of requesting a statement of the healthfulness of the water.

Personal Prophylaxis.—The individual can do much toward protecting himself from an attack of cholera, and in so doing, he is at the same time doing much to prevent the spread of the disease, for each single case may become a separate center for the origin of new cases.

Fear should be met by fortitude, courage and carefulness; panic itself is conducive to the onset of an epidemic disease, by rendering the system less able to resist the epidemic influence. There is harm in sending patients to country districts where the drinking water is derived from wells, which in a majority of cases suffer more or less from infiltration of organic matter from a privy vault, too often near by the well or the stable. So it is better to advise patients in comfortable homes to stand their ground, live as usual, to be temperate, to dress warmly, to avoid overfeeding on the one hand, or starvation on the other, to eat regularly, and take regular and sufficient sleep, to keep away from promiscuous crowds, to refuse to admit any person from an infected house or district, to take no article of any sort from an infected house, and to drink boiled water.

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[1] This liquid is made as follows: Sulphate of copper, 50 grams; water, 1 litre.

Chamber vessels should be disinfected before emptying them, and the ordinary water-closets should be disinfected twice daily during the prevalence of an epidemic.

It is advised that all funerals be privately conducted at such times, and in no case is it allowable to attend the funeral of choleraic victims.

If sickness occur, at once call a physician in whom you have confidence, and in no case trust advertised "cholera preventives," however much lauded.

SECTION III.

CHOLERA HYGIENE AS APPLIED TO MILITARY LIFE.

BY

ELY McCLELLAN, M.D.,

MAJOR AND SURGEON U. S. ARMY.

CHAPTER XLII.

CHOLERA HYGIENE AS APPLIED TO MILITARY LIFE.

THE hygiene of permanent military stations differs in no essential respect from that which applies to life in isolated dwellings and tenement houses.

Enlisted men are furnished with clothing, food and shelter by the general government. That these three requisites of life are properly provided, and that no one is deprived of his portion of them, is the duty and constant care of commanding officers. Enlisted men when sick and unable to perform duty are entitled to the professional care of a medical officer, who has under his charge a hospital most abundantly supplied with all that is necessary for the welfare of the men of the command.

It is the duty of the commanding officer of a post, and of the officers immediately in command of troops, to see that each enlisted man is protected in the receipt of all bounty from the government, and that he renders the full service in return. It is the duty of the medical officer to guard the public health of the command; to preserve the hygiene of the post at the highest available point, and to cause, so far as may be in his power, the destruction of what Sternberg has so aptly termed "our invisible foes."

A permanent military post should afford an example of cleanliness in all things. Nothing should be permitted to remain in or around barracks or other buildings which may be prejudicial to health. Sewer connections, where they enter buildings, should be trapped and ventilated. Conveniences which require sewer connections should be reduced to a minimum. Dormitories should be freely ventilated, well lighted, and during the cold months properly warmed. Water-closets and urinals should under no circumstances be permitted under barrack roofs. Drains and sewers should be sufficiently often flushed to secure a removal of all débris deposited in them. A frequent and lavish use of disinfectants should be made. The quarters occupied by officers should be subjected to the same careful supervision as is bestowed upon the habitations of enlisted men.

The water supply of a garrison should be constantly a subject of observation. Water should be had from the very best obtainable source. The condition of supply pipes should be an object of constant care. When necessity compels the use of water from cisterns or wells, they should be kept in the most perfect order, and the greatest care should be had to avoid the introduction of any surface washings. When there is the least suspicion as to the purity of the water supply, it should always be boiled and filtered before use, and all members of a command should be enjoined to use only water so prepared.

Whenever it is practicable, water-closets should be provided for the use *of all* at a military post: they should be connected with the system of sewers which should empty in such position as will in no way interfere with the public health.

When it is impracticable to employ water-closets, privy vaults should be constructed in such positions as to secure isolation. These vaults should be so cemented as to prevent leakage, be frequently subjected to the action of disinfectants, and at short periods emptied of their contents. The disposition of the débris from such vaults should be a matter of careful solicitude. The lines of natural drainage around a post should be always a matter of care. They should be kept constantly free and unobstructed throughout their length.

The ration of the enlisted man in the U. S. Army is most liberal—it is the endeavor of officers charged with such supplies to furnish articles only of superior quality. The greatest care should be observed in the preparation of food in all company kitchens.

The clothing of a soldier is amply sufficient for all his requirements. In no other army, by no other nation, are enlisted men more perfectly cared for, and the American soldier is furnished with luxuries unknown to soldiers in other armies and to the majority of the working classes in any community.

The chief causes of sickness and mortality among troops are to be found more in the individual habits of soldiers than in their surroundings.

Whenever an epidemic of cholera or yellow fever occurs in the vicinity of a military post, it is well to cause the removal of troops to such position as will free them from immediate contact with the disease. The rules advanced by Niemeyer, governing such circumstances, are always good: "Start soon enough." "Go as far as possible." "Do not return until the last trace of the disease has disappeared." Circumstances, however, will, especially in cholera epidemics, conspire to prevent the abandonment of a military post. At such a time a strict system of non-intercourse with infected or even suspected localities must be maintained. All enlisted men should be rigidly confined to the limits of the military reservation. A camp of observation should be established, in which all recruits or soldiers received from without should be placed. A watch should be kept upon privies, and any man obliged to make use of them more than once in twenty-four hours should be taken under observation and all subsequent dejections be made in such vessels as will allow his condition to be ascertained by inspection. No enlisted man should be permitted to eat, drink, or sleep outside his proper quarters.

While it is advisable for all persons to be careful in their diet, and rigidly to avoid all articles of food that are known to be indigestible, it is also necessary not to occasion too sudden and radical a change. Excesses of all kinds should be avoided; the digestive apparatus should be encouraged to the performance of its duty by the presence of good, well-prepared, wholesome food. Wine, brandy, and malt liquors may not only be allowed, but when used in moderation are extremely useful in averting those debilitating influences which so often prevent the system from repelling disease; but their use should be positively interdicted whenever undue stimulation results.

It is a well-established fact that when the digestive organs of an individual are in a normal condition cholera is rarely developed, but those whose digestion is disturbed readily fall victims to the disease. Experience has shown that a debauch predisposes to cholera whenever the disease is epidemic; and yet all drunkards in a cholera-infected community do not take the disease. Exceptions simply prove the rule. Water being the vehicle by which cholera is most actively distributed, should, before being taken for any domestic use, be boiled (and ebullition maintained for at least thirty minutes), and when cool passed through a filter.

The surveillance exercised should be constant and far-reaching. A case of cholera occurring within the limits of any military command should lead to the adoption of immediate and active measures to *stamp out* the disease. The patient should be at once placed in a comfortable but isolated position. Everything belonging to him and which he has had in use before coming into the hands of the medical officer, as well as every place at which he is known to have been present since the inception of the disease, should be disinfected. All his excreta (vomit and dejections) should be received in vessels properly prepared. The surface of his body should be occasionally bathed in the disinfecting solution; and in a fluid of the same character, the hands of attendants and the various utensils employed about the case should be frequently washed. When access can be had to a perfected line of sewers which empty into a rapidly flowing stream, the various fluids (largely mixed with disinfectant) may be thrown into the sewer; but where such sewer at any portion of its course has a cesspool as the recipient of its contents, then deep and narrow pits should be dug, and into them the fluids should be emptied. Everything belonging to and in use by a cholera patient should be thoroughly disinfected. If articles of clothing or bedding are to be destroyed by fire, *they must first be rendered inert by disinfection,*[1] *then burned.* Should it be necessary to bury the excreta, the bottom of the pit before recommended should be covered with crystals of sulphate of iron and chloride of lime in bulk; and upon this mass the *disinfected* fluids should be thrown. Each time a bucket of the latter is emptied a sufficient quantity of fresh earth should be thrown upon it, and before final closing of the pit a solution of sulphuric acid in the proportion of four ounces to a quart of water should be placed upon the mass. Then the pit should be securely covered with earth closely packed and raised some inches above the surface of the surrounding ground. It is very important to remember that all the dejecta of a cholera case contain the seeds of the disease, and that the infectious principle is not confined to the rice-water passages alone. It is a matter worthy of careful consideration whether the passages before and after the stage of rice-water are not the most virulent. *They should be treated as if they were.* In these latter days long and exhausting marches of troops but seldom occur. In changing station the services of common carriers are most frequently called into requisition, and, of these, railroad lines have absorbed the traffic almost to the exclusion of water-transportation. In each cholera epidemic which has visited the United States, steamboats were the most active agents in distributing the disease to moving bodies of troops, and of introducing the disease into permanently garrisoned posts. Formerly bodies of troops destined for Texas, California, or the Northwest Territories made the greater portion of their journeys by water transportation, and the long cholera epidemic from which the army suffered from 1848 to 1856 was undoubtedly due to their constant conveyance on the Mississippi, Ohio and Missouri river steamboats.

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[1] See preceding section.

But a few years ago the Missouri river was the boundary line of civilization. From the river posts to those on the extreme frontier, long and tedious marches were made, over territory where now great trunk lines of railroad whirl troops in as many days as formerly would have required months.

But a few years ago the transportation of subsistence stores, clothing, and camp equipage was accomplished only by wagon trains. Sick teamsters and other train-employees not infrequently were carried on the wagons containing clothing or food. These trains were often months upon the road, were constantly halted upon old and often-used camp grounds, and were frequently the carriers of infectious diseases. Now, the same class of articles securely packed in freight cars are delivered at or comparatively near most army posts, and the transportation used in the absolute delivery at the post storehouses is that which is under the constant supervision of the military authorities.

The advantage gained to the army by this new system is very great. Healthy recruits are no longer sent from healthy depots to contract epidemic cholera on either ocean or river steamers; for, in spite of the assertions of Pettenkofer, *ships do become cholera-infected,* and do transmit the disease to individuals who come upon their decks in absolute health. Apart from the fatigues of long marches, troops are no longer liable to be temporarily encamped on old and infected grounds where they may receive the cholera poison. No longer are they the agents in the diffusion of the disease to isolated communities or to other bodies of moving men.

The experiences in the United States of all cholera epidemics from 1832 to 1873 can scarcely be reduplicated. The disease in its every type remains the same, but the liability of contact on the part of troops has been materially lessened. But while the probability of troops coming in contact with and becoming infected by cholera has been greatly lessened, still by the increased facility and rapidity of railroad travel the possibility of a wide-spread diffusion of the disease has been considerably enhanced. In the American Practitioner for August and September, 1874, I endeavored to call attention to the marked agency of common carriers as porters of disease. In the "History of the Cholera Epidemic of 1873 in the United States," published in 1875, I again endeavored to present the subject for consideration; and I would once more press the same view. On cholera-infected steamers, where either passengers or crew can gain access to the mass of merchandise transported, the diffusion of cholera may be wide-spread and *mysterious.* Who can say what results may not follow the voiding of one cholera dejection on a box of dress-fabrics (of any kind), or on a bale of cotton; and yet the opening of one or the other may occasion a serious local epidemic of the disease, which might be advanced as another instance in proof of the ground-water theory, or some equally absurd view.

If the excreta of individuals suffering from cholera are the active agents in the reproduction of that disease, has not the common carrier who transports an individual suffering in any stage of that disease over two or three hundred or more miles of territory in a day a very active agency in "sowing the seeds" of cholera? The limited express which leaves New York each morning traverses the long distance to Chicago in but a little over twenty-four hours. Suppose a single individual on that train has choleraic diarrhœa: who can answer when, and where, and how often his dejecta are sown broadcast? It may be in an uninhabitable locality, but it is just as likely to be on entering some town or village, or they may be thrown upon the door-sill of some outlying farm-house.

Below the saloon end of each car there should be a tank for the reception of all excremental matter, containing an active disinfectant, and at fixed points along all railways these tanks should be moved and emptied by trained employees. Could this be accomplished, we would hear less of mysterious outbreaks of cholera, which can only be accounted for on "endemic" theories.

While long marches are no longer a necessity in the movements of troops, it by no means follows that the United States soldier is no longer liable to duty in the field. In the exchange of station from one department to another, the march is still made. This is especially true as to the mounted regiments. In many instances military posts are located from one to two hundred miles from the nearest railway. On the frontier the depredations of hostile Indians occasionally demand extended and prolonged field operations. For the instruction of troops in field duties, summer campaigns are frequently made.

Should cases of cholera occur among troops in camp or on the march, the same line of management as has already been indicated should be observed. The hospital camp should always be at a convenient distance to the leeward of the main camp. Deep narrow pits should be dug to receive the excreta, and it should always be a matter of great care that all privies, *for the well and for the sick*, should be so placed as to prevent the possibility of infection of any wells or springs in their vicinity. No matter what may have to be abandoned, a sufficient number of ambulances or wagons should be provided for the transportation of the sick. If possible, the daily march should be made. The *morale* of the command is preserved by action; a daily change of camp-ground is a daily removal from the cholera germ that has escaped from the human body, for this (although they may be told that the germs have been destroyed by disinfectants) is greatly dreaded by the soldiers. It is well to avoid in a march the ordinary line of travel. The simplest case of diarrhœa should be taken from the ranks and placed in the hospital wagon, and every such case should be placed under treatment so soon as it is discovered.

Before leaving a camp-ground it should be a matter of solicitude that nothing is left which by any possibility may convey the disease to those who may follow. After the line of march is taken up and all have left the site, a police party should inspect every portion of the ground. They should see that every pit is securely disinfected and solidly covered; and débris, no matter of what character, should be either burned or buried. Before each day's use the ambulances and wagons should be thoroughly washed with disinfecting fluid. At the rear of the column a sanitary detail should march, who should inspect the dejecta of any man who may have occasion to fall out by the way. Even a solid, healthy-looking dejection should be treated with suspicion, and should receive the disinfectant before being buried.

Men should under no circumstances be permitted to leave the ranks for drinking-water. A supply which has been boiled and strained should be carried on the march; and it is advisable that the men carry cold tea in their canteens.

There remains but a consideration of the disposition which should be made of cholera-infected fabrics. That all inanimate objects, especially woolen and cotton fabrics, can and do act as storehouses of the specific seeds of cholera has been so often proven that it is not now necessary to reiterate the fact.

Among soldiers the articles upon which such a fixation can occur are all articles of clothing, blankets, bed furniture and tents. After use about a patient attacked with the disease, it is in my opinion unsafe to continue any articles in service, even should a careful disinfection have been attempted. Each and every article which has come in contact with cholera sick should be thoroughly treated with disinfectants, dried and finally destroyed by fire; on the subsidence of the epidemic. This advice is based upon experience in past epidemics. It is a radical opinion; but when epidemic cholera comes to be treated by radical measures alone, when theories impracticable in all their proportions, and which are persisted in simply for personal aggrandizement—give place to radical and practicable procedures—Epidemic Cholera will be unknown upon the American Continent.

How shall a case of cholera be managed when it develops upon a railroad train in motion? To allow the dejecta of such a patient to be emptied upon the road-bed is criminally to assist in the spread of the disease. No other vessels being at hand, the coal box, one of which lined with zinc is in every car, should be brought into requisition, and each discharge into it should be covered with ashes brought from the engine. At the first station reached, the patient should be removed from the train and placed in reliable hands. A supply of disinfecting agents should be obtained; the contents of the vessel employed to receive the dejecta should be actively treated with the germicide and buried; the car which had been occupied by cholera should be washed with the disinfecting agent, and during the remainder of the journey be fully ventilated. Every window should be open so that the air contained by every portion may be constantly changed. It is imperative that the excreta of a cholera patient leave the car with, not before, the patient.

PART SEVENTH.

THE TREATMENT OF CHOLERA.

BY

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OF NEW YORK.

CHAPTER XLIII.

GENERAL THERAPY AND THE TREATMENT OF THE DIFFERENT STAGES OF AN ATTACK.

General Remarks.—It is safe to assert that in no other disease have the remedies employed and the general methods of treatment been more numerous, than in the attempted cure of Asiatic cholera. Some writers have manifested surprise and dismay at this bewildering state of affairs. It is only too true that an examination of the results achieved by the most intelligent therapeutic efforts is far from encouraging. Yet there is no just ground for the expression of surprise that countless remedies should have been tried and recommended in the treatment of the disease. On the contrary nothing would seem to be more natural. For, on reflection, the multiplicity of counsel regarding the therapy of cholera must appear to be only the inevitable consequence of advising action in accordance with the extremely divergent views held concerning the nature of the disease. Again, the lack of success that has necessarily attended all efforts to save the doomed, or cure the incurable, is in a measure responsible for the suggestion of the most extravagant and ridiculous means of attaining this end. Indeed the whole history of medicine abundantly exemplifies the rule that, the further removed from human ken and power a disease may be, the greater will also be the number and variety of agents recommended for its positive cure. If the subject were a less serious one, it would be quite amusing to scan the absurd notions that have arisen, and still arise, whenever epidemic cholera makes its appearance in our most civilized countries. This applies not only to the pardonable popular fallacies concerning it, but to theories and recommendations emanating from the ranks of the medical profession itself. Stillé alludes to a number of such views in the following way:

> Cholera has never prevailed in any country without giving rise to extraordinary theoretical and practical divagations. One physician in the earliest American epidemic gravely proposed, as the best mode of checking the diarrhœa, to plug the anus with a soft velvet cork. Another, in England, suggested that the "blood may be kept circulating by putting the patient on his back on a board and keeping up a rocking, see-saw, to-and-fro movement from eighty to one hundred times a minute." Another had the revelation that the disease is essentially a "paralysis of the sympathetic nerve and want of performance of the organic functions, with deficient vitality of the mucous membranes," and that its proper remedies are "bleeding, turpentine, and cool drinks, without heat and stimulants;" and to this remarkable doctrine a well-known physician gives his adhesion, thus: "The cause, I firmly believe, is a union of the poison with the sympathetic."[1] Were not the evidence so palpable, it would hardly be believed that such irrational ideas should have been published concerning a disease which had then been under observation by the whole medical profession in Europe and America for more than thirty years, and in Asia for a much longer period.

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[1] Times and Gazette, Aug., 1866, p. 209; *ibid.*, Nov., 1866, p. 555.

To this short list a few other views, more recently propounded, may be added in further illustration of the subject. Thus Dr. Grotius, a former naval surgeon, who was decorated for his services during the epidemic of 1865–66, and who appears to have an irrepressibly facetious vein, thinks that cholera is a disease characterized by a little colic and diarrhœa, and a vast amount of fear.[1]

Hence this learned gentleman, in all seriousness, advises patients in the algid stage of cholera simply to react from their fear and colic and thus to turn the crocodile tears of the expectant heirs into genuine grief. For he is convinced that, as a rule, cholera is a bad joke invented for the terrorization of mankind. It seems incredible that such extravagant nonsense should be published by physicians who have enjoyed the privileges of a liberal education. Yet examples of this kind might be multiplied almost *ad libitum.*

Take the following statements, made by an Italian, who proves, to his own satisfaction at least, that cholera

> is nothing more than a consequence of the displacement of the worms of which we are made up. A sudden fear, an indigestion, or any other disorder which shakes but does not kill the delicate mass of worms, will arouse them, and they, leaving their normal place, will assail and suffocate the patient, as frequently happens in nursing children. The rice pap discharges are nothing else but a mass of smaller worms with their excreta, triturated by the current of the larger worms which assail the belly, stomach and throat. The greater or less intensity of the assault is proportionate to the greater or less intensity of the disease, and hence the *cholerine,* the *cholera,* and the *cholerone.*[2]

In accordance with this brilliant etiological conception of the disease, the inventor thereof proposes the use of "remedies to pacify and replace the worms, and to kill those which are enraged when they threaten our lives with deadly assaults, viz.: For cholera and cholerine, strong coffee, olive oil, rum, bitter decoctions, etc. For the *cholerone* the same . . . according to the strength of the patient."

A recent French writer, M. Alliot,[3] defines cholera as an obliteration or chemical modification of the metachemical essence (nervous or electric fluid) which constitutes the vital principle of man. Such being the case the proper remedy is pilocarpine. This may not appear to be quite logical, but it is certainly very amusing.

From this digression we turn now to the serious consideration of the best means at our command for a rational treatment of patients attacked with the disease. And here, at the very outset, we would ask the reader to remember that the power of drugs to influence an aggravated attack of Asiatic cholera is often *nil,* and at best exceedingly limited. But is not the same thing observed in other truly malignant diseases, as well as in accidents that have disabled some vital organ? We must not ascribe, as has been done, the occasional marvelous recovery from cholera to any curative effects of the particular medicinal agents employed in such exceptional cases. Enlightened physicians, all the world over, freely admit that certain grave types of fever, some attacks of malignant scarlatina or diphtheria, may so quickly and completely overwhelm the system, as with a deadly venom, that the agency of drugs, even when combined with the most judicious general management, is utterly impotent to effect a cure. And let us not forget that there is no disease which, in its malignant manifestations, acts with greater energy and speedier virulence than Asiatic cholera. It cannot, therefore, be justly construed as a reproach to the science and art of medicine that we have no power in such cases of stemming the tide that hurries the patient to an inevitable doom.

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[1] La Vérité sur le Choléra. Précautions à prendre pour éviter sûrement le fléau, et moyens radicaux pour le guérir. Brussels, 1884.

[2] Quoted from an Italian letter published in the Chicago Medical Journal and Examiner, January, 1885.

[3] Traitement du Choléra par la Pilocarpine. Paris, 1884.

Having thus frankly acknowledged our helplessness with regard to the worst types of the disease, we must on the other hand emphatically assert our power to deal successfully with cholera in its earliest and mildest manifestations. It is true that even here our power may be limited, but to dispute it completely would be as much of an error, as to claim it with regard to the graver attacks of well-marked cholera.

At this point the question naturally arises, if cholera is a specific disease, dependent upon the invasion of intestinal parasites, why is it not possible to abort an attack by the early employment of parasiticides. There are several answers to this query. In the first place, assuming the truth of the micro-parasitic doctrine of cholera, it has been shown by Koch and others that the destruction of the specific bacilli within the intestinal canal is, in the present state of our knowledge, impracticable. For it would in most cases necessitate the employment of drugs that would prove as surely fatal to the host as to his parasites.[1] Again, as for example in trichinosis, by the time the symptoms of an invasion make diagnosis possible, the fatal harm may be already accomplished, and the most potent parasiticides would then arrive too late. Without wishing to discourage too much the continued search for a specific against cholera, it may be well to remember that, should one be discovered, it would fail to check an attack of the disease except when employed sufficiently early to prevent the very symptoms upon which, in most cases, we base our diagnosis of this malady.

Semmola[2] has recently published some suggestions regarding the management of cholera that have a direct bearing on the question under discussion. He boldly states his conviction that the parasitic doctrine can never be taken as the point of departure for rational treatment. For, as intimated above, apart from the difficulty of using enough of a sufficiently strong parasiticide to kill all the microbes, their poisonous action (ptomaines) is already accomplished by the time we have positive symptomatic indication of their presence in the human body. Indeed Semmola goes so far as to state that the diarrhœa of cholera, instead of being due to the local and primary visitation of the microbes, may be regarded as the first result of poisoning of the nerve-centers and abdominal sympathetic, which have an undeniable influence over intestinal nutrition and circulation. He thinks it probable, also, that in cholera there occurs intestinal absorption of the poison generated by the microbes, which, entering the circulation, acts successively upon the various nerve centers, presiding over the functions that are observed to become progressively disturbed.

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[1] It is of course possible that future research may provide us with some agent that, while a reliable parasiticide, may be devoid of toxic properties so far as the human being is concerned.

The dilute mineral acids are remedies which have a large experience in their favor, and rest also on an apparently sound theoretical basis. Weak chlorine water may also be thought of; and it is, of course, possible to give corrosive sublimate so dilute as to be harmless. But even if these remedies kill germs we must remember that germicides are not antidotes to ptomaines and like poisons. See also Dr. Sternberg's article on Internal Disinfection, in the preceding part.

[2] Nouvelles Recherches thérapeutiques sur le choléra asiatique, in Bulletin général de therapeutique, December 15, 1884, p. 482.

For him it is certain that all anti-parasitic remedies hitherto recommended, amount to nothing more than "scientific charlatanism." The "quinine" of cholera, if the term may be used, has not yet been discovered, and Semmola thinks that it is not likely to be found by laboratory methods. Still, he believes it is a great mistake to confound paludal with choleraic infection. And certainly the exhibition of anti-periodics in cholera is useless, and the reported cures are readily explained as errors of observation.

In view of the difficulties briefly alluded to in the above, it is doubtless a legitimate question whether treatment by drugs is indicated at all in the management of cholera-patients? This question, as already intimated, must be answered in the affirmative. And this, too, in spite of the extremely pessimistic views entertained by some writers of extended experience.

As long ago as 1847 Parkes[1] wrote as follows: "No medicine has yet been found which can counteract the changes in the fibrine, and nullify the first effect of the choleraic virus in the blood. The antidote to this tremendous virus has not yet been discovered, and the resources of modern European science have opposed its destructive action with as little effect as the untutored efforts of the most barbarous nation to whom its ravages are known. The efforts of European science have indeed, it appears to me, in many cases proved hurtful. The attempt to cut short the disease, and to rouse the system from a state erroneously compared to debility and to exhaustion, has certainly often accelerated the progress of cholera. It is a most important practical point that cholera runs a certain course; when the algid symptoms have once shown themselves, a case cannot be cut short; even in the mildest forms, warmth does not return altogether for a long time, but when the disease has reached its acme the patient is invariably seen to remain for some hours in a peculiar state, during which time nature seems to be gradually repairing the injury which has been done. Therefore when a person is cold and almost pulseless, with a heart embarrassed and a respiration nearly arrested, the attempt violently to rouse him from this state by strong stimulants, by warmth to the surface, by continued frictions, or by measures of a like kind, seems to me to be founded altogether on a misapprehension."

There is no gainsaying the truth of much that is contained in the foregoing quotation. As illustrative of opinions also partaking of a decidedly hopeless character, we may cite some statements quite recently made by Dr. D. B. Simmons,[2] who has had a very large experience in the treatment of cholera in many of the countries of Eastern Asia, from Japan to India. He points out that the statistics of the late epidemic in Europe show a mortality of 50 per cent. His own statistics of the mortality in Asia give the same average rate of 50 per cent. In the former case the majority of the patients received treatment directed by men well informed concerning all the remedial agents known to modern scientific medicine. In the latter class, however, not one patient in a thousand was seen by physicians of the Western school. In fact great numbers of them were not visited by the doctors of any school, preferring to put their trust in charms and prayers to their various divinities, having from long experience had quite as much reason for belief in the curative powers of one as of the other. He thinks it is not necessary to add the moral to the above.

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[1] Researches into the Pathology and Treatment of the Asiatic or Algide Cholera. By E. A. Parkes, M.D., London: 1847, p. 203.

[2] The Medical Record, March 7, 1885.

So long ago as 1865 Velpeau[1] wrote as follows: "It is not impossible that a notable number of cholera patients recover without remedies or specifics, and in spite of them; and the proof is that in all epidemics—in the violent one of 1832, as well as those of 1849 and 1854—more than one-half of the cholera patients have recovered—have recovered by methods of treatment most opposed and various."

Against such views, the unqualified acceptance of which would contraindicate all medical interference, we maintain that accumulated clinical experience of an unimpeachable kind makes it appear extremely probable that the early stages of specific cholera are amenable to treatment. Dr. Leale[2] goes so far as to state that "a very large proportion of even the severest cases of the disease may end in recovery if the proper medicinal treatment is early resorted to, and our profession can point with pride to its success in promoting a convalescence, or, at the early stage, in preventing the violence of the disease from killing the sufferer."

So that, while strongly deprecating blind interference, we nevertheless hold that the physician is not justified in merely folding his hands in resigned inaction, in the face of this unpromising disease. Therefore when called upon to assume the charge of a case, even in the advanced stage of the attack, his counsel must not be withheld on the ground that nothing will avail. Death alone can command a cessation of honest effort to rescue the poor sufferer from his impending fate. Though fully convinced that his best endeavors are likely to prove futile, duty clearly demands that the physician do all in his power to assist the victim of cholera, in the same way that he would unhesitatingly assist a sufferer from any chronic form of incurable disease. If he cannot stay the morbid process, he has at least some power to relieve suffering, assuage anxiety, and stimulate failing hope.

He should be careful not to make the mistake of the good Kentucky doctor, who when grievously importuned to prescribe for a cholera patient in apparently hopeless collapse, added to his prescription "to be given every hour until he dies," and found his patient almost convalescent at his next visit. (Peters).

The Treatment of Premonitory Diarrhœa and Cholerine.—Under this and the following heading we propose to sketch such a general plan of treatment as we conceive to be in accordance with our present knowledge of the disease, but which is above all things supported by rational clinical empiricism. This may be profitably supplemented by some account of particular methods or remedies that have received the sanction of authority, or whose claims to recognition have been warmly urged, more particularly during the recent European outbreak.

In the prevalence of an epidemic, the safest rule in practice is to treat every case of diarrhœa, no matter how slight, with the utmost care, and on the principle that it may be premonitory of a grave attack of Asiatic cholera. It goes without saying that the physician must studiously avoid causing unnecessary apprehension, or spreading alarm among his clientele.

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[1] L'Abeille Médicale, November 13, 1865.

[2] The New York Medical Journal, February 21, 1885.

Yet by exercising the necessary amount of tact, the families composing his practice may be informed of the urgent necessity of attending immediately to the most insignificant intestinal derangements, that ordinarily might be disregarded.

If slight diarrhœa occurs and is clearly traceable to errors or excess in eating, and if there is reason to believe that undigested food is still irritating the bowels, a mild laxative, such as castor-oil or the usual salts with a little opium, may be safely given. No possible harm can result from a single dose of an unirritating laxative. And even should the sequel show that the case was one of choleraic diarrhœa, the physician may rest assured that the attack was not aggravated by his remedy. No sooner has the laxative produced its effect of removing the offending matters, than *any* persistence of diarrhœa should be followed by the prompt administration of opiates in small or moderate doses, repeated at short intervals. If there is no distinct evidence pointing to the presence of irritating bowel contents, the preliminary laxative is contraindicated, and treatment by opium may be at once begun. If the distress is gastric rather than intestinal, an emetic dose of ipecac is a preliminary measure of undeniable advantage. In fact Briquet, Laugier and Ollive, and quite recently Fabre, commonly employ this drug, and warmly recommend it not only in the premonitory stage of an attack, but also after the disease has actually begun.

Fabre[1] uses it even when grave phenomena already exist, provided the tongue is coated sufficiently to indicate gastric derangement. He remarks that it is surprising to witness the calm that follows the vomiting, to observe the pulse rise, a moisture bedewing the limbs, the cramps cease, the countenance lose its pinched appearance, and the general condition of the patient improve. Saline emetics are, however, universally condemned, and without sharing the sanguine views of the French writer just cited, it may yet be worthy of remembrance that when an emetic is advisable our choice should fall upon ipecacuanha in preference to other similarly acting drugs.

But to resume: A few drops of some mineral acid (nitric, or hydrochloric, but preferably sulphuric) largely diluted with water and taken frequently, may be added to the treatment by opium; not merely in the hope of destroying, as Macnamara and many others believe, "the specific cholera process going on in the intestinal canal," but because it is grateful and slightly astringent, and also for the purely empirical reason that patients have seemed to be benefited thereby.

More important, however, than the use of opiates and acids, even at this early stage, we hold to be the general regimen of the patient. He should be instructed to cease all work at once, if possible to eat and drink nothing for several hours, and to lie down either in bed or on a sofa, preferably between blankets, with a flannel bandage applied over the abdomen. A well-aired room, in which an equable temperature is maintained, should be provided for the patient's occupancy. Bland fluids, such as egg-water or mucilaginous decoctions, also soaked toast, gruels, farina, rice, may be allowed, if after about eight hours of rest and abstinence there is no return of the diarrhœa. Beef-tea and all concentrated meat broths should be interdicted, even those prepared with muriatic acid. For several days following a warning of this kind, the patient should be directed to strictly regulate his diet, and carefully avoid all fatigue and nervous perturbation. Should the diarrhœa return after a number of days, he must once more fast and rest as before, and again only gradually venture on returning to his normal diet.

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[1] Traitement du Choléra. Leçons faites par le Professeur A. Fabre. Marseilles, 1884.

This simple line of treatment is the most rational as well as successful mode of dealing with the mild diarrhœal manifestations that are so frequently seen during the prevalence of an epidemic. It is true that it will not always be possible to induce, for example an active business man to carry out measures that entail a certain amount of discomfort, and necessitate absence from his "office" for hours or even days. Yet obedience to the above advice should be strenuously urged, and in a large proportion of cases will meet with little or no opposition.

Regarding the preparations of opium, it is best to use the tinctures *e.g.* laudanum or paregoric in preference to powders, pills, or any of the alkaloids of the drug. In some cases it may be advisable to combine an astringent with the opium, but generally laudanum alone, or in strong peppermint water, is preferable to such combinations. Kino, catechu, and tannin are among the most serviceable drugs when astringents are required.

Macnamara was in the habit of distributing "cholera pills," among the well during the prevalence of an epidemic. Each pill contained a grain of opium and two grains of acetate of lead, the directions being that one be taken every hour until purging stops. It is certainly advisable in times of cholera to have bureaus, offices, factories, schools, and indeed all places where people congregate, supplied with some simple opiate, so that the first manifestations of diarrhœa may be promptly met by appropriate medication. Of course the medicine should be placed in intelligent hands, and each bottle or pill-box, must be labeled with explicit directions for use.

For children and very delicate persons paregoric is preferable, as all the spices and aromatics are germicides. Laudanum, if distasteful, may be given in peppermint or some other aromatic water, of which aq. menth. virid, aq. carui, anisi, allspice or cloves are not to be despised. In other cases a solution of morphine in acidulated water, or in aromatic water, may be more useful and acceptable.

Dr. Fergus,[1] of Glasgow, had a number of rules drawn up and hung in prominent places of that city, during the prevalence of cholera there. They contain practical suggestions, as applicable to-day as they were then, and are therefore here reproduced, with certain changes that have suggested themselves to the editor.

1. Do not be afraid of cholera, or make it the topic of conversation. Fear and all the depressing passions are injurious.

2. Do not take brandy; it is not a preventive, and it does harm by disordering the action of the stomach and bowels.

3. Do not make any change in your usual diet, if it is simple and of easy digestion; take it moderately, and at regular intervals, as long fasting is injurious. Carefully avoid excess in any intoxicating beverage.

4. Avoid excessive fatigue. If overheated, beware of any sudden chill, and see that the skin is kept comfortably warm. If the disease appears in winter, much benefit may be derived from wearing a flannel belt round the body, covering the stomach and bowels.

5. As soon as cholera appears in a town, a bottle of acidulated solution

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[1] Glasgow Medical Journal, 1866.

of morphine or laudanum or paregoric, and a graduated measure should be kept in every house, place of business, factory, or wherever, in fact, there are a number of people gathered together. Persons traveling should always have it with them, easy of access. During the prevalence of an epidemic, one intelligent person in each factory, etc., should take charge of the health of the inmates, acting in the quasi capacity of "house-physician," and urging all under his or her care to at once attend to the slightest relaxation of the bowels. He should warn them that absence of pain does not signify absence of danger.

6. Should the slightest diarrhœa occur, the individual so attacked should receive at once the appropriate quantity marked on the bottle as corresponding to his age. The person attacked should be at once considered a patient, and conveyed home, placed in bed, and kept warm. If chilled, warm water bottles should be put to the feet. If the first dose of the "cholera mixture" has not checked the looseness, the patient should take a second after an interval of from one-half to one hour. A flannel cloth dipped in turpentine or essence of peppermint may also be placed all over the stomach and bowels for from forty minutes to an hour; or a large, soft, warm poultice of linseed meal and mustard for one or two hours. Medical assistance should be summoned if the diarrhœa has not promptly yielded. In the meantime a third and last dose of the medicine may be taken, one or two hours after the second one.

7. It is well for the patient to remain very quiet, preferably in bed for two or three days after the diarrhœa is checked. This is to be strongly urged, for the patient often feels so well that he objects to remain in bed.

8. To relieve thirst, a piece of ice may be given, or a mouthful of iced water, or plain soda water. In some cases, even more fluid can be taken at a time; but it should then be directed by the physician. All food should be abstained from for from fifteen to eighteen hours after the medicine has been taken. Afterward the diet should for two or three days consist of such food as rice, sago, arrowroot, Indian corn flour, tea and toast, and similar bland substances. About the third day broths, chicken soup, or beef tea may be taken. Condiments, such as pepper, salt, cinnamon, etc., are useful. Green tea is more astringent than black.

9. *These rules are for the first stage, and for it only, namely, the diarrhœa.* If a person has neglected the first warning, and is in the second stage, having cramps, vomiting, and stools like rice-water, without smell, the patient should, until medical assistance arrives, be placed in bed between blankets and surrounded with bottles of hot water. He may receive a little ice or an occasional mouthful of cold water. The limbs may be rubbed, but not too violently, with some liniment, quickly procurable.[1] No medicine is to be given until the arrival of the doctor.

If the invasion of cholera is not preceded by the mild manifestations of simple diarrhœa, but begins at once with watery purging, the above plan may require certain modifications and additions that must necessarily again vary with the abruptness and severity of the onset. In order to insure quiet, overcome pain, and perhaps quickly influence the bowels, it is best to administer hypodermically from six to fifteen minims of Magendie's solution of morphine. If it be found desirable to maintain the action of the drug, laudanum in spice water, or paregoric, may then be used. But should the stomach prove rebellious to the laudanum, hypodermics may be from time to time repeated, the quantity being adjusted to the varying indications of the particular case, but rarely again reaching the maximum of the initial dose. Bed-rest is absolutely necessary now, and indeed, as a rule, the patient's general malaise will not incline him to disobey orders. It is advisable to place a large poultice made of equal proportions of ground mustard and flaxseed meal over the entire abdomen, and after decided reddening of the skin, replace it by ordinary poultices, opium liniment on cotton flannel, warm flannel alone, or simply a hydropathic bandage, fitting snugly but not uncomfortably around the abdomen.[1] The latter especially often gives the patient a sensation of grateful ease that it is very desirable to maintain.

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[1] If there is time, an opium liniment may be made with one or two ounces of laudanum, one ounce of soap liniment, and an ounce or two of cologne water. It is very efficacious and agreeable.

Vomiting may still be absent, or, when present, it may be possible to restrain or suppress it by allowing small bits of cracked ice, cold champagne, or simple water charged with carbonic acid. Drop doses of the wine of ipecac, or 1 to 3 grain doses of oxalate of cerium, may likewise aid in controlling the vomiting. If the patient now grows very thirsty, there is no objection to allowing him to drink plain water, that it is well to have previously boiled, then cooled, shaken and iced. Claret or small quantities of brandy or whisky may also be added to the water, but need not be forced upon the patient. It does not seem advisable to allow the imbibition of large quantities of liquid at one time. Small quantities given at short intervals answer much better. Any attempt to prevent collapse by using large quantities of alcoholic stimulants is decidedly reprehensible.

Small quantities of tea-punch, hot or cold, preferably hot, made of green tea, arrack, or some other nice light spirits, to which the rich can add champagne, makes a light and digestible drink which will warm, without overstimulating. Vermouth wine, which is merely a light white wine, flavored with aromatic and slightly bitter herbs is excellent. Sour and Rhine wine is better than heavy sherry, which should not only be pure, but diluted with water; 10 per cent. of alcohol is as strong as any wine or diluted spirits should be used. (Peters).

Although cholera patients, as a rule, crave cold fluids, it is nevertheless worthy of remembrance that, in some cases, hot weak tea, or peppermint water or simply very hot water, is borne better than iced drinks, and may be used in place of them. In this connection it is perhaps deserving of notice that Macnamara and several other competent writers urge abstinence from all fluids. They rely solely on the use of bits of ice, allowing the patients an unlimited supply of this cooling substance. On the other hand, Macpherson from his own experience in one of the severest cases of cholera on record which recovered, says he will never deny a cholera patient a reasonable amount of water, either plain or carbonated.

Any other symptoms arising at this period call merely for cautious treatment directed toward their mitigation, but all "meddlesome interference" is very much to be deprecated. Nothing seems to the writer's mind more irrational than to attempt by potent and varied drugs, frequently given in large quantities, combined with the use of harassing external measures, to do battle against a foe that in many cases is clearly beyond the reach of all treatment.

The following table is based on 800 cases of cholera treated in the provinces throughout England and Scotland in 1854, and represents the percentage of failure, after the use of various remedies in premonitory diarrhœa:[1]

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[1] Flannels wrung out in hot cayenne pepper water are also useful.

	Per cent.	Or, including deaths as failures.
Catechu, kino, etc.,	59.0	59.0
Salines,	41.9	41.9
Eliminants,	25.0	25.0
Calomel,	34.0	25.3
Calomel and opium,	18.9	22.0
Stimulants,	16.0	21.8
Chalk and opium,	13.8	17.1
Acetate of lead and opium,	11.2	14.0
Opium,	8.6	13.7
Chalk mixture,	3.6	5.0
Sulphuric acid and opium,	2.6	4.0

Having thus briefly outlined the simple management of premonitory diarrhœa and cholerine, we will next turn our attention to

The Treatment of Well-marked Cholera.—Although we have repeatedly expressed ourselves to the effect that we have practically no power to always arrest a fully-developed attack of Asiatic cholera, nevertheless the principles which should guide the physician's recommendations and actions seem to us to be plain and unequivocal. The enforcement or even encouragement of any rigid theoretical plan of dealing with the unfortunate subjects of a pronounced attack, seems utterly reprehensible.

As in other diseases, so too in cholera, the most reliable indications for medical interference are furnished by a knowledge of the disease-processes underlying the symptoms observed by the physician. Accordingly, if it becomes evident that the normal absorbent functions of the gastro-intestinal surfaces are completely reversed, it is worse than useless to introduce large quantities of powerful drugs and stimulants either from above or (as has been quite recently often done) from below. We say worse than useless, for the reason that the uncertainty in duration of the different stages of cholera makes it possible for reaction to occur with enough medicine or alcohol, or both, in the alimentary canal to kill the weakened patient by suddenly acting upon his system immediately after the rapid revival of absorption. There is not the slightest doubt that sudden death, so frequently observed shortly after apparent reaction, has been due in some instances to such causes. The oral administration of drugs is, therefore, only indicated while intestinal absorption continues. Again, the subcutaneous connective tissue so quickly shrinks during collapse that its power of absorbing is largely reduced or completely suspended.[2] Nevertheless whenever potent remedies are demanded, hypodermic injection offers a better chance of effective medication than the swallowing of mixtures, pills, or powders, and also than the much vaunted enteroclysis of Cantani and other recent Italian writers.

Knowing then that the internal use of drugs during collapse is of no avail, it seems unnecessary to enumerate the countless host of remedies that have been and continue to be recommended by writers of all nationalities.

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[1] General Board of Health. Report on the Results of the Different Methods of Treatment, by the Treatment Committee of the Medical Council, 1855.

[2] Still subcutaneous injections of weak acid water, or even of salt and water, have at times appeared to stem the tide of outflow from the bowels, as tonics and astringents acting from behind. Compare also Hayem's views in next chapter.

Before the occurrence of collapse, and during the stage of profuse discharges it is generally advisable to administer small doses of morphine hypodermically. This may at least to some extent quiet the patient and diminish his sufferings. But the drug should never be "pushed," as for example is commonly done in peritonitis. For the relief of persistent thirst small quantities of iced fluids, such as plain water, carbonic acid water and especially water weakly acidulated with mineral acids or freshly expressed lemon juice, and similar drinks, may be frequently given. Little bits of ice taken every few minutes are also allowable.

Some writers have insisted on completely withholding these harmless and grateful beverages, believing that they increased vomiting and favored the intestinal flux. But there is not the slightest foundation for entertaining such an opinion. Indeed, it would be downright cruelty to refuse the momentary relief that cool drinks often give the patient. It is only too true that thirst is not quenched thereby, and that the stomach may immediately reject the eagerly swallowed liquid.

Yet in some cases the relief is so apparent that we have no hesitation in affirming it to be the physician's duty to see that drinks are not withheld. In well-marked collapse it is best to stop all medication. Moreover, in this condition heat applied to the body, frictions, embrocations, and similar well-known measures have no power to call back to the surface the fast-ebbing tide of warmth. But before that time such measures may be employed to advantage. Semmola has strongly urged the warm bath, repeated every two or three hours as a possible preventive of collapse. Yet this must often be fatiguing and injurious. He admits also that to bathe a patient during collapse would have no more effect than to deal similarly with a corpse. But on the other hand he insists that the warm bath has a calmative effect, and a rallying influence, especially noticeable in the stage of premonitory diarrhœa.

Dr. J. C. Peters has used pieces of unslaked lime, wrapped in wet clothes and put in bowls under the bedclothes successfully in incipient collapse. The heat produced is very great and grateful, and there may possibly be some disinfecting power in this process. A pack in blankets wrung out in hot cayenne or mustard water is useful; and it is very easy when the blankets cool or dry off, to pour very hot water upon them without removing them or disturbing the patient. Slaking lime used in the way just mentioned is easy of application and does not tire or weaken or disturb the patient.

An energetic doctor once gave his collapse patients a hot bath, made them drink all the hot water their stomachs would hold, and then pumped not only their bowels but their bladder full of hot water, and complacently said if any one could do more to warm a patient up he would like to hear of it. We can only add, slaking lime in bed. (Peters).

We will return to Semmola's views on the treatment of cholera later on, merely mentioning here that the temperature of the water used for the baths, as recommended by him, should not fall below 100° F., nor much exceed 104° F. If the muscular cramps prove rebellious to gentle frictions with warm flannels or slightly stimulating or anodyne liniments, if they remain uninfluenced by a hypodermic injection of morphine, the physician may allow the inhalation of chloroform carried to the point of partial anæsthesia. This may be repeated from time to time without fear of disastrous effects on the heart. But unless thoroughly reliable and competent trained nurses be in waiting, the attending or some other physician must personally direct its administration.

Dr. Maclean[1] says that:

> Cramps are best relieved by the use of chloroform, given in doses of five or six minims in a little water, and if vomiting be excessive a little may be sprinkled on a pad of lint covered with oiled silk or gutta-percha tissue and applied to the epigastrium; or spongio-piline may be used for the purpose. I have used chloroform in this way both externally and internally, very freely, and always with good effect.

Dr. Macnamara speaks strongly in favor of chloroform. Having pointed out the great importance to the patient of procuring rest, he says: "In furtherance of this latter object, I know of no remedy more efficacious than chloroform. If the patient is in much pain and very restless, I strongly advise his being placed under the influence of this anæsthetic. The chloroform must be administered by inhalation, and its full effects may be safely induced; or at any rate we may put the patient into a sound and comfortable sleep. . . . We must be prepared to continue the action of the chloroform, perhaps for four or five hours, or even longer, according to circumstances."

Dr. Parrot[2] also favors the employment of chloroform in cholera. He used one to two drachms of chloroform daily in severe cases, and less in mild ones. The vehicle was water 100 grammes, and syrup of quinine twenty grammes. This mixture was given in tea, a tablespoonful every half hour; at the same time iced beef-tea was given very frequently in small quantities. Warmth was applied to the skin, and dry and stimulating frictions were used. Chloroform given in this way calmed the anxiety and epigastric pain, and seemed to diminish the frequency of the vomitings, which were also less painful.

Dr. Hartshorne,[3] in 1854, spoke as follows concerning the use of chloroform:

> Experience has shown that, taken into the stomach, it is as totally free from danger as any other drug; and its employment is destined to be yet much more widely extended; a fluid-drachm of chloroform taken by the stomach is not more than equal, in soporofic effect, to thirty or thirty-five drops of laudanum. In doses of fifty to seventy-five drops (about fifteen minims), I have given it every half hour for several hours together. It differs from the opiate preparations in the promptness of its hypnotic action, the much shorter period of its duration, a less degree of cerebral oppression, and the absence of all stimulus to the circulation. It might be called a "diffusible narcotic," comparing in this respect with opium as ammonia does with alcohol. To produce much effect with it, repeated doses at short intervals will be necessary. Its pungent property causes it to require plentiful dilution, which is of course facilitated, by the action of some demulcent. Perhaps the orgeat syrup is the best. Every fluid drachm of chloroform should have at least two fluid ounces of water with it when taken; and it will need, if in ordinary gum mucilage, considerable agitation to re-suspend the particles immediately before swallowing. When taken in aqueous mixture alone, however, unless in very small doses, it produces nausea with some persons. This is entirely prevented by the addition of a strong aromatic, or still better by giving the chloroform in aromatic tincture. From the ready solution and kindred action of camphor with chloroform, their combination has become a very common one. For many purposes, however, a still better preparation is a sort of chloroform paregoric, or compound

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[1] Lectures on the Treatment of Cholera, by Deputy Inspector-General Maclean, M. D., Professor of Military Medicine. London Lancet, Feb. 3d and 17th, 1866.

[2] Gazette hebdomadaire, December 8, 1865.

[3] American Journal of Medical Sciences, January, 1854.

tincture of chloroform, *e.g.* ℞. Chloroform, f ʒ ij; sp. camph. et. tinct. opii, āā f ʒ iss: ol. cinnamon, gtt. viij; alcohol, f ʒ iij. M. et fiat tinctura. Dose, from five to thirty minims, or more, as required. The most admirable effects have been witnessed from the administration of chloroform, as above combined, in malignant cholera.

Recently Dr. M. Desprez[1] has also advocated the employment, both externally and internally, of chloroform. He believes that by this means from 80 to 90 out of every 100 persons in the algid stage of cholera could be saved. He bases this extravagantly hopeful view on his own experience and on that of other physicians in Asia Minor, India and Cochin China. The following is his formula:

Chloroform	1 gram (15 minims)
Alcohol	8 grams (2 drachms)
Acetate of Ammonia . . .	10 grams (2½ drachms)
Syrup of hydrochlorate of morphia .	40 grams (1¼ ounce)
Water	110 grams (3½ ounces)

Dose: A tablespoonful every half hour.

Without sharing Desprez's sanguine views, we nevertheless have reason to believe that chloroform may often be used with advantage, especially for purposes of inhalation. But ether is objectionable, and nitrite of amyl either inhaled or injected beneath the skin has not realized the expectations that were formed concerning it.

Another common symptom that may become so distressing as to require the inhalation of chloroform is singultus. But before having recourse to this means, the hypodermic use of morphine, an epigastric sinapism, a spice poultice or a blister should be tried to stop the hiccough. Where there is reason to believe that a limited amount of absorption still takes place in the alimentary canal, various stimulants may be administered in a tentative way, in order to secure the prevention of collapse. Alcoholic beverages, such as Burgundy, Tokay wine, port wine, brandy and water, or champagne, may then be given. In the same way, if indicated by the condition of the patient, various excitants such as the ammoniacal preparations, camphor and musk may be employed. But, as previously pointed out, if collapse comes on in spite of their moderate exhibition, they should be at once discontinued. Even then an attempt to stimulate cardiac action by the hypodermic use of similar medicaments, including brandy and ether, may be made. But this too must not be persisted in.

Obviously it is impossible to lay down fixed rules for the guidance of the practitioner in this direction. But, as already stated, the general principles governing intelligent action are by no means as obscure as might be supposed from the confused and conflicting statements of many authors.

The writer may be permitted to say here that he strongly deprecates the blind tapping about among various supposed remedies, in the vain hope that a lucky accident may result in the discovery of a really curative agent. The physician should make every honest effort to stay the march of the disease by employing those means the action of which he is familiar with. But to use the living bodies of cholera patients as suitable material for blind pharmacological and other experimentation seems to the writer as irrational as it is inhuman; nevertheless perhaps in desperate cases apparently desperate means are allowable, provided always they be neither cruel nor irrational.

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[1] Du Traitement Rationnel de la Période aiguë du Choléra Asiatique. Paris, 1884.

Treatment During Reaction.—If the patient rallies from his collapse and enters with a flickering flame of uncertain life upon the period of reaction, the great value of careful nursing and strict diet is if anything more apparent than ever before. Drugs avail little or nothing. Small doses of opium are sometimes given with advantage, but as a general thing the patient will fare better without narcotics. Solid foods are absolutely dangerous. Fluids, however, may be allowed somewhat liberally. Milk at first diluted with plain water, or carbonic acid water, egg-water, decoctions of arrowroot, sago, or rice well-strained and seasoned with plenty of salt, are all to be commended. After a few days, broths and soups thickened with oatmeal, rice, barley, or farina may be allowed. Coffee and tea may now also be permitted in a more concentrated form. Gentle stimulation by generous wines will be found necessary in many cases. Only very gradually, however, can a diet consisting of soft-boiled eggs, meats, concentrated soups, bread and potatoes be resumed.

Relapses are to be treated with the same caution and on the same principles as the primary attack. When it is remembered that the brunt of the battle had to be borne by the gastro-intestinal tract, the pedantic supervision of the patient's diet will appear not only pardonable but absolutely essential.

Again in **the Management of Complications and Sequelæ,** the fact should not for a moment be lost sight of, that just as in typhoid fever, so too in cholera, the healing of intestinal lesions must not be jeopardized by a careless allowance of too much or improper food. Lebert says truly, "Indigestion is as fatal in the convalescence of cholera as in typhoid fever."

Having pointed out the necessity of keeping in mind the weakened condition of the gastro-intestinal apparatus, it appears unnecessary to burden this account with detailed directions concerning the treatment of the various morbid states that complicate or follow an attack. The intelligent practitioner will apply the same general principles to this task that guide him in the management of those conditions when not connected with cholera.

The typhoid stage is properly a complication or sequel of the period of attack, and a more or less profound renal disturbance is generally the dominant symptom of that condition. If hot drinks and the induction of perspiration by the use of the wet pack and warm blankets do not relieve the kidneys, it is only exceptionally proper to try more energetic remedies, such as diuretics and pilocarpine. If the patient does not pass any urine within thirty-six hours after reaction has commenced, Macnamara is in the habit of prescribing the tincture of cantharides as recommended by Dr. Francis. He gives ten minims in an ounce of water every half hour until six doses have been taken. He adds: "If this treatment does not cause urine to pass, we must, after the sixth dose, discontinue the medicine for twelve hours, and then repeat it in precisely the same way, giving six doses more, ten minims each. . . . I have seen this treatment followed by the most satisfactory results in very many cases." Finally the cautious exhibition of digitalis, which is also a heart-tonic, should not be overlooked at this period.

CHAPTER XLIV.

SPECIAL METHODS OF TREATMENT AND PROTECTIVE INOCULATION.

HAVING sketched in the preceding chapter a plan of treatment which the editor believes to be simple, rational, and based as well upon the present state of our knowledge regarding cholera as upon former therapeutical experiences, we are now prepared to examine some of the methods of treatment advanced by other writers. Especially those therapeutical recommendations which are of more recent date may be of sufficient interest or novelty to warrant our attention. Although it is not intended to give a complete resumé of modern therapeutics, nevertheless all the more important writings will be considered. Following the general plan of this volume, it has been deemed expedient to abstain from lengthy criticism, so that whenever comment seemed really called for, it has been made in the briefest manner compatible with the clear expression of the editor's personal views.

Writing as long ago as 1860, Drasche showed that the more or less enthusiastic claims advanced in favor of the curative power of many remedies and methods of treatment had not stood the crucial test of time, and had nothing in their favor save the warm recommendations of their respective advocates. The enumeration made at that time may be repeated with advantage at the present day, as it is curious to note how tenaciously some of the older remedies are still clung to in many quarters. The first measure to be mentioned is venesection. This was practiced at one time in a routine way by most Indian physicians.[1]

Next comes the exhibition of calomel, also first advised by Indian practitioners. Searle, Annesley, Johnson and others employed the drug in quantities of about twenty grains repeated hourly until the stools looked green. Later on it was employed in smaller doses.[2] Drasche condemns its use altogether.

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[1] On the subject of venesection in cholera, Stillé says: "There was a time when certain physicians, carried away by conceptions of the disease evolved from their inner consciousness, maintained that it consisted essentially of a spasm of the blood-vessels, and that the natural and legitimate cure for it was to be found in bleeding. No theory is so gratuitous or absurd, but cases may be found which appear to justify it, and in this instance also examples were not wanting to illustrate at once the truth of the theory and its successful application. Longer experience, however, and a more correct conception of the disease, have long since condemned this method, which was almost as dangerous as it was irrational."

[2] Stillé, in referring to the treatment of Asiatic cholera by mercurials, especially according to the method of Ayre, has so well expressed the views that are now

Ipecacuanha—Drasche asserts that this drug produces no alterative effect upon the intestinal tract. He denounces the eliminative method in whatever way its action is obtained. Whether emetics or laxatives be used, the effect is always injurious.

Alkaline carbonates, as recommended by Hamburger, Maxwell, Mackintosh and others, are useless.

Spirits of ammonia (Steart), liquor ammon. (Ebers), are useless or injurious.

Carbon trichloride, used by Troschel, Simon and other Berlin physicians, is superfluous. Reinhardt and Leubuscher found it a rather useful excitant. Henoch and Lebert, however, showed that in grave cases it was quite useless. The following drugs also belong to the category of remedies of doubtful utility, and in fact Drasche believes that they should be withheld. Fuming nitric acid (Hope, Bowes, Prchal), bismuth, nitrate of silver (Lever), strychnia (Abeille), phosphorus (Paul) aqua calcis (Pasquali, Siemerling), valerianate of ammonia (Oettinger), hydrated oxide of iron (Heigl), sulphuric acid,[1] manganic acid, pyroligneous acid (Biertz),

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entertained by the majority of competent writers that we cannot do better than here quote his words. He says:

"It is now conceded by all enlightened physicians that mercurials in large or in ordinary doses are worse than worthless in epidemic cholera. In 1832, Dr. Ayre of Hull, England, proposed another method of using calomel, to which he adhered in treating this disease. It consisted in the administration of very small doses of calomel at short intervals, and with each of the first doses a few drops of laudanum. Such a method, if not carried too far, certainly has the merit of sparing the patient a great deal of the perturbative treatment against which we have, in the preceding pages, protested. But that was not at all the notion of its proposer. He claimed for it positive and active virtues. He stated, as the fundamental ground of his plan, that 'the primary and leading object of the treatment must be to restore the secretion of the liver.' He did not in the least doubt that he was able to do this by the administration of mercury—not, indeed, by a direct action upon the liver itself, but indirectly and sympathetically through the stomach, and by the healthy and specific stimulus imparted to it, by which the due secretion of the bile is promoted. It is, indeed, difficult to conceive of any stimulus that calomel could impart to the stomach that would not be equally given by any other non-irritant and insoluble powder—subnitrate of bismuth, for example. Indeed, Ayre himself relates the case of a man who in an attack of cholera took during three days no less than five hundred and eighty grains of calomel, and recovered without any soreness of the mouth. But the plan which he finally elaborated was different. It was to give small doses of calomel repeatedly—in the premonitory stage one grain every half hour or hour for six or eight successive times, or, if this failed, every five or ten minutes—and in the stage of collapse one grain and a half every five minutes. In a few cases of extreme severity two grains of calomel were given every five minutes for an hour or two, and then the ordinary dose of one grain was resumed. But this was not all: with every dose of calomel was associated one, two, or three drops of laudanum, so that if these doses were repeated frequently the patient received a very efficient amount of the narcotic during the attack. Indeed, Ayre attributed to it the virtue of sustaining the vital powers under the depressing influence of the disease, and of removing or abating the cramps, as well as of retaining the calomel in the stomach. (A Report on the Treatment of the Malignant Cholera. London, 1883.) From the preceding account it follows that the treatment of cholera by small doses of calomel with laudanum is founded on an erroneous assumption of the mode of action of calomel, and that whatever efficacy the plan of treatment may possess may with more justice be attributed to the opium, whose effects we know, than to the calomel, whose action, so far as it is known at all, has no conceivable relation to the disease for which it was given. However this may be, if the results of Ayre's treatment are compared with those of other plans, it exhibits very little if any superiority.

[1] The utility of sulphuric acid in cholera, properly diluted and given as advised

nitre (Stevens), gunpowder (Roux), castor-oil (Johnson),[1] croton oil (James), chloride of lime and chlorinated water (Prchal), chlorate of potash (Aron), chloric ether (Fuller), chloroform (Vincent), animal charcoal (Briett), hashish (Villemain), stachys anatolica (Fauvel), protoxide of nitrogen and oxygenated water (Thenard), common salt used in baths and clysters (Göz) and for intravenous injections (Dieffenbach), intravesical injections of water (Piorry), inhalation of volatile aromatics (Haller), and finally the transfusion of blood, the use of electricity and curative gymnastics.

Drasche is not a thoroughgoing pessimist, however, for he firmly believes that lives may often be saved by timely and rational treatment of a symptomatic kind. The following account[2] embodies his own ideas of the management of cholera patients:

> He attaches great importance to a rigid diet in the very commencement, nothing but soups being allowed. From a neglect of this precaution, has arisen the disappointment which many physicians have found in remedies for the diarrhœa. Only a limited quantity of fluids may be taken, and this if possible warm. If the thirst is excessive, ice may be allowed. Patients have stated that the use of cold draughts was followed by marked intestinal rumbling, and soon after a watery dejection, in spite of preventive medicines. His remedy for the diarrhœa is opium, which he prefers to give in the form of tincture (tinct. opii. crocata). Should the diarrhœa continue several days without amendment, astringents should be substituted for the opium. Of these he prefers rhatany and tannin in doses of five grains of each.
>
> As the collapse approaches, stimulants are indicated, to excite the nervous system and quicken the circulation. He likes the æthereal oils, as of cinnamon, mint and juniper; musk has also a similar action. If time presses, diffusible stimulants, as warm wine, champagne, rum, or punch, may be employed. Sulphuric and acetic ethers (stimulant anti-spasmodics) have also a decided action upon the cramps and vomiting. Used for inhalation they improve the pulmonary circulation, and relieve dyspnœa. The effect of ether, thus employed, has often been surprising, especially with young persons. In a short time after the commencement of the inhalation, the pulse has improved, the temperature of the body risen, the cyanosis lessened, the cramps have diminished, and reaction has set in.
>
> As an additional means of restoring the circulation, frictions should be employed, and the body enveloped in warm coverings. Sinapisms are also considered as very useful. If reaction is imperfect, stimulants should be used, mild or strong, as the circumstances require. If excessive, ice may be applied to the head, and cold water allowed. If there is a tendency to cerebral congestion, leeches and cups should be employed. To restore the urinary secretion, mild diuretics, such as seltzer waters, citric acid, or citrate of potassa, are indicated. If necessary, warmth may be applied to the loins and frictions made with ungt. digitalis, the oil of juniper, or turpentine. A free use of cold water is also allowable.
>
> If the diarrhœa continues during reaction, astringents, such as tannin, extract of calumba and extract of rhatany, should be administered. The same remedies are indicated if diarrhœa is present in consecutive fever. Vomiting and singultus are treated by sinapisms to the epigastrium. So long as the period of reaction continues, the patient must remain in bed and confine himself to a diet of soups alone.
>
> For the diarrhœa and vomiting which sometimes continue during convales-

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in the preceding chapter, cannot be called in question. Drasche condemned it without having extensively employed it, and we must, therefore, take exception to his statement, according to which it should be classed with the useless drugs.

[1] The castor-oil treatment of cholera has been extensively tried and is now generally abandoned as unworthy of confidence. Johnson's idea of eliminating the specific poison from the alimentary canal by the promotion of purging was doubtless ingenious. But apart from the practical failure of his methods, we have, in the light of our present knowledge concerning cholera, no reason to believe that we can rid the system of this poison by castor-oil or any similarly acting drug.

[2] The language is borrowed from Burrall.

cence, nux vomica is a suitable remedy. So long as there is any indication that the digestive organs are still suffering, the diet must consist principally of nutritious soups.

From this brief resumé of Drasche's views it will be seen that the rational treatment of cholera, as we understand it to-day, is in many respects quite similar to what it was 25 years ago.

The plan of treatment as mapped out by Niemeyer, Lebert, Eichhorst, Kuessner and Pott[1] and other representative German writers, resembles in all its essential points the method of Drasche, just described.

In the premonitory diarrhœa of cholera Lebert claims to have obtained excellent results from the use of the following pills:

℞. Argenti nitratis	gr. ix.
Solve in aquæ destillatæ	q. s., et adde.
Extracti opii	gr. ivss.
Pulveris althæ	gr. xxij.
Extracti gentianæ	q. s.
Misce, et fiat massa in pilulas xxx.,	dividenda.

Let one of these pills be given two or three times a day in cases of slight diarrhœa, and two pills three times a day in the more severe and obstinate cases.

Numerous authors of standard text-books on medicine, and many representative English, French, Italian and Spanish writers, while they advise treatment that differs considerably in its details, nevertheless adhere to the same general plan of management that has previously been described.

We must now turn to the specific recommendations of some of the most recent writers. And we will begin with an Italian author, Semmola,[2] who claims to have employed with gratifying results, and naturally commends as worthy of extended trial, a plan of procedure upon which he has bestowed the title of "physiological treatment." By this he means the employment of measures suitable for increasing the power of resistance of the system against the invasion of the choleraic poison, without, however, troubling the organism with powerful pharmaceutical preparations. The principal points in this mode of treatment are:

1. Absolute repose of the organs attacked—that is of the gastro-intestinal tract—by a strict fast maintained from the very first appearance of diarrhœa. This fast must be enforced at once upon the appearance of a liquid stool, without waiting to see whether the diarrhœa is merely accidental or is premonitory of cholera. The taking of even a single cup of beef-tea may suffice to develop a grave attack of cholera. The author thinks the necessity of this absolute fast is too little insisted upon, for he regards it, he says, as the sheet-anchor of safety. The same complete fast is to be maintained during the period of reaction until at least 24 hours have elapsed since the last liquid stool. The author says that he has seen a return of all the grave symptoms of the algid stage following the too early administration of a few spoonfuls of beef-tea.

2. Arousing the physiological powers by measures therapeutical indeed, but bordering on the physiological. This consists in the application of heat in the form of hot baths of a temperature of 100° to 104° F. repeated as necessary. Hot baths have been given often enough in cholera, but they have not been given at the proper time. The suitable time to em-

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[1] Die acuten Infections Krankheiten, Braunschweig, 1882.

[2] Bulletin Général de Thérapeutique, December 15, 1884.

ploy them is in the beginning of the disease, before the algid stage has set in. For the object is not to warm the chilled cutaneous surface, as was formerly supposed, but to maintain the normal physiological relations between the cutaneous surface and the gastro-intestinal mucous membrane. The hot bath, of 100° to 104°, excites the very rich peripheral nervous plexuses, and then by reflex action the nervous centers of the circulation. The hot bath favors also the elimination with the perspiration of the toxic principles, which are the cause of the nervous and other symptoms characteristic of the algid stage. The bath should be repeated every hour or two, and in the intervals the patient should be kept covered with woolen clothes and should take some warm aromatic and alcoholic drink. Semmola advises that the baths should be begun as soon as the patient, even though the diarrhœa be slight, feels any epigastric uneasiness whether vomiting have occurred or not. The uneasiness or distress is the precursory signal of a terrible struggle, and no time should be lost in putting the patient into a hot bath for ten or fifteen minutes. In other cases also, when there is simple diarrhœa without any epigastric discomfort, if the diarrhœa is not speedily arrested by the ordinary treatment, fasting, rest, opium, etc., the writer counsels a recourse to the hot bath. He says he has seen hundreds of cases of diarrhœa rebellious to ordinary remedies, which would probably have eventually passed into actual cholera, but which yielded at once after one or two hot baths.

3. The administration of small doses of opium to blunt the nervous centers and thus render them less susceptible to the influence of the toxic agent. This is independent of the favorable influence which opium may exert upon the intestinal secretion. The stupefying action of the drug upon the nervous centers increases their power of resistance to the cholera poison, and thus really constitutes part of the physiological treatment of the disease.

Some of Semmola's suggestions are worthy of being heeded. The advantage of obtaining as much rest as possible for the digestive tract is self-evident. Nevertheless we cannot enforce a prolonged regime of fasting in every case menaced with an attack of cholera. The weak would, in place of being benefited thereby, suffer positive injury. Nor does the indiscriminate employment of warm baths strike us as a measure free from possible harm. It should be restricted to those cases, in which the physician feels satisfied that no mischief can be wrought, rather than extended to all, in which a possible benefit might be obtained.

Professor Hayem,[1] the well-known hæmatologist, has recently published *in extenso* his views on the treatment of cholera. The following brief summary embodies the points on which he appears to lay the most stress. He first draws attention to a circumstance, which all competent writers are agreed upon, namely, how important it is to remember that, in a very large proportion of cases, cholera begins with gastro-intestinal troubles, and that if these are arrested in their incipiency, a grave attack may possibly be prevented. It is, therefore, necessary during an epidemic to attend at once to all intestinal or digestive disturbances, and especially to diarrhœa. If there is indigestion or if there are signs of an overloaded stomach, ipecac may be given in a dose of 20 to 30 grains. It may even suffice, in certain cases, to produce emesis by tickling the fauces with a feather or by causing the patient to drink large quantities of warm water.

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[1] Bulletin Général de Thérapeutique, November 30, 1884, and Traitement du Choléra, Paris, G. Masson, 1885.

In the treatment of the premonitory diarrhœa, opium may be given by the mouth, or in combination with an astringent by the rectum. Subnitrate of bismuth has often been given with advantage in doses of 2 to 3 drachms during the twenty-four hours. Hayem states that he has also employed the black sulphide of mercury so highly recommended by Cadet with success. He gave it in doses of 15 grains every hour until twelve doses had been taken, and found that it speedily checked the diarrhœa. He recommends also the salicylate of bismuth, as suggested by Vulpian, asserting that it is decomposed in the intestinal canal forming oxide of bismuth and salicylic acid, acting thus at the same time as an astringent and an anti-zymotic.

After the disease has become fully established, when the intestines are filled with fluid, the remedial agents which may be given are with difficulty absorbed. When the attack begins suddenly without prodromic symptoms, or when these early symptoms have not been treated, Hayem still advocates the employment of ipecac, and says that it often is effectual in arresting the vomiting. Purgatives, which have been so often used, are rather harmful than otherwise. Opium may also be given at the beginning of this stage, but its exhibition should not be long continued, as the drug may accumulate in the intestines, and then be rapidly absorbed in massive dose when reaction sets in. But salicylate of bismuth is of especial value in this stage, and may be given to the amount of 2½ drachms a day in doses of 15 grains each. The black sulphide of mercury appears to be of little efficacy at this period. Often, however, the administration of any remedy is interfered with by the continual vomiting, and recourse must then be had to hypodermic medication. The muriate of morphine may be given in this way in doses of one-seventh of a grain, and is often of great service in controlling the vomiting, diarrhœa, and nervous symptoms. These hypodermic injections may be employed until the algid stage has become established, after which time they are useless, as absorption then ceases.

A mustard plaster or a small blister over the epigastrium may be of service to control vomiting. In the algid stage Hayem strongly urges the employment of intravenous saline injections. Owing to the excessive transudation of serum into the intestines, the blood is greatly reduced in volume; it becomes inspissated, circulates but slowly in the vessels, and carbonic acid accumulates in it to such an extent that it may even become acid in reaction. The transfusion of blood, as recommended by Dieffenbach, is irrational, since it is only the fluid elements that demand renewal. Hayem asserts that there is practically no danger in increasing the bulk of the circulating fluid by saline injections, since he has shown by experiments on animals that a quantity of water equal to the entire mass of the blood may be added without causing any serious inconvenience. These experiments were practiced on healthy animals whose vascular system was already normally full.

The simplest fluid for these injections is a solution of 5 parts per thousand of chloride of sodium in water. To this may be added one part of carbonate of soda which is indicated by reason of the increased alkalinity of the blood. The solution is to be previously warmed and passed through three thicknesses of good filter paper, or better yet through a heated porcelain filter such as is used in sterilizing culture fluids. The injection is to be made in the same way as in the transfusion of blood, and is the more easily accomplished since there is no hæmorrhage. One of the veins at the elbow or the saphenous vein is to be chosen. A transverse incision having been made through the integument, the subcutaneous cellular tissue is seized with the forceps and divided by blunt pointed scissors until the vein is exposed into which the canula is inserted by a single thrust. Another solution which Hayem regards with great favor is the preceding one, with the addition of 25 parts per thousand of sulphate of soda, which has been found to be an excellent preservative of the integrity of the red globules. It has been shown that sulphate of soda introduced directly into the circulation does not act as a laxative, but rather causes constipation, and Hayem suggests that not only may it arrest any further transudation of fluid into the intestines, but possibly it may even promote the reabsorption of that already escaped from the vessels. For the sake of convenient reference the formula of this solution is here given:

Carbonate of Soda	1 part.
Chloride of Sodium	5 parts.
Sulphate of Soda	25 "
Water	1000 "

If the amount of fluid to be injected is more than a litre (1¾ pints) it would perhaps be prudent to reduce somewhat the proportion of the sulphate of soda. M. Hayem estimates the amount of injection needed by the proportion of red globules or the dosage of hemoglobine in the blood. Thus if the proportion of red corpuscles is increased to 7,000,000 or 8,000,000 per cubic millimetre, instead of 4,000,000 or 5,000,000 which is the normal quantity, about two litres (3½ pints) must be injected, since the entire mass of blood in the healthy adult is estimated at about 5 litres (9 pints).

In certain cases, owing to an abundance of cellular tissue about the veins and to the collapse of the vessels from the disturbed circulation, it may be impossible to practice these intravenous injections. In such cases Hayem would not abandon the attempt to restore the normal fluidity of the blood, but would throw the injection into the cavity of the peritoneum. The solution, whether thrown into the veins or into the peritoneum, should not be warmed above the normal temperature of the body.

The feebleness of the cardiac pulsations may contribute to the production of collapse in the algid stage, and is to be met by the employment of external heat and diffusible stimulants. The painful cramps may be relieved by passive movements, dry frictions, massage, or frictions with chloroform liniment. The nervous symptoms, agitation, cardialgia and depression, may be effectually quieted by cold affusions.

The intravenous injection of fluid, practiced with the idea of making up for its loss by intestinal transudation, is not a new idea. But neither the older nor the most recent trials were followed by results that were sufficiently lasting to encourage physicians in the universal adoption of such a procedure. There is little doubt that a failing heart may be stimulated to renewed activity by being supplied with fresh fluid. But when the latter reaches the intestine it will certainly escape from vessels that are unable to retain even the natural serum of the blood. Practiced with the idea of temporary cardiac stimulation, the intravenous injection of fluid may take its place by the side of other legitimate procedures. But undertaken for the purpose of curing the patient, by maintaining the fluidity of his blood, even Hayem's warm recommendations will fail to obtain for it universal professional sanction.

Dr. Lereboullet[1] in reviewing all the recent suggestions regarding the therapy of cholera concludes that the following measures will meet all possible indications. Premonitory diarrhœa must be combated by opium and anti-spasmodics, as well as iodoform in the shape of pills. He believes that the multiplication of the specific microbes may thus be held in check.

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[1] Du Traitement du Choléra, in Bulletin Général de Thérapeutique, September 30, and October 15, 1884.

In the algid stage of an attack, the inhalation of nitrite of amyl, injections of ether, practised *coup sur coup* until a decided effect is observed, are necessary. Hydro-therapy and inhalations of oxygen are likewise to be recommended. If absorption appears to have come to a standstill, he urges the employment of copious intravenous injections, frequently repeated. Finally he points out that the practitioner can only hope to treat his patients with success, if he is able to visit them repeatedly and at short intervals, so that all the varying indications may be immediately acted upon.

The presence of soda in the intestinal contents and its diminution in the blood are due, Tardani thinks, to endosmosis.[1] The indication is, therefore, to arrest this process, and this is to be accomplished by the introduction of a small amount of sulphureted hydrogen together with an acid fluid into the intestine. The author injects into the bowel six or seven grains of sulphide of sodium dissolved in thirty times its weight of water, and follows this at once by another injection of two ounces of water acidulated with sulphuric acid.

In a little pamphlet from the pen of Dr. Hanhart[2] a "regime of thirst" is recommended as a prophylactic during the prevalence of epidemic cholera. The author means thereby a considerable reduction in the amount of fluid ordinarily imbibed. Should an attack nevertheless occur, the patient must refrain altogether from taking liquids. Frictions always calm the restlessness. Nitrogenous and carbonaceous food is alone admissible.

Accordingly the patient must eat tender meat, preferably prepared with vinegar or lemon-juice. Also oil, rum, brandy, and sugar. Chocolate also answers the same purpose. In fact, whatever dries the body is useful. This author forgets to publish the results he has obtained with this extraordinary and unique plan of "fighting cholera." It is quite obvious, however, that his method of treatment has nothing in its favor. It is mentioned only in order to be condemned as utterly irrational.

M. Burq, the tireless champion of the therapeutic efficacy of metallotherapy, published a little brochure[3] shortly before his death, applying these principles to the treatment of cholera. In this he urged as a certain means of prophylaxis the charging of the system with copper. Each person was advised to take, according to his age, from one to six pills containing each ⅓ grain of binoxide of copper. Among the immediate followers of Burq the copper treatment was regarded with much favor. But the results were, as might have been foreseen, indifferent or unfavorable. Further trials of this medicament are not called for.

Dr. Huguet[4] maintains that all that is necessary is to remove the morbific agent of the disease from the economy as speedily as possible by the natural channels. To accomplish this end he stimulates all the excretory functions of the lungs, the skin, the kidneys, the intestines and the stomach, giving if need be remedies to excite those various organs to increased action. This, it will be observed is an eliminative method practiced on a much larger scale than Johnson's castor-oil treatment. It does not recommend itself for further trial, being based on erroneous assumptions. Apart from this the method is fraught with positive danger, on account of the weakening and depressing effect it necessarily exerts upon patients subjected to such ordeals.

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[1] Solution du Problème du Choléra Morbus, per Gaetano Tardani, 2d edition, Paris, 1884.

[2] La lutte contre le Cholera, par H. Hanhart. Paris, 1884

[3] Du Cuivre contre le Choléra et la Fièvre Typhoïde. Paris, 1884.

[4] Extinction du Choléra. Guérison en quelques Heures. par la Méthode naturelle. Paris, 1884.

In a number of publications issued during the latter part of the year 1884, Professor Arnaldo Cantani[1] relates the mode of treatment advocated and employed by him during the recent epidemic in Italy. Accepting the bacillar theory of the disease, he cautions against the employment of alkalies such as bismuth, magnesia or chalk, in the treatment of the premonitory diarrhœa, and advises per contra the use of acids, especially hydrochloric or lactic in the form of lemonade. In addition a little laudanum may be given in a hot aromatic infusion. The patient should go to bed at once and should be warmly covered so as to promote diaphoresis. But he urges especially the use of rectal injections, thrown as high up into the bowel as possible. His formula for these injections is the following:

Deodorized tincture of opium, . . .	30 to 50 drops.
Tannic acid, ...	45 to 90 grains.
Gum arabic, ...	1 to 1½ ounces.
Infusion of chamomile, ...	3½ pints.

In regard to the use of this injection in the beginning of the disease, Cantani says that he is persuaded from practical experience that, employed in time, it will almost always arrest the rice-water discharges and cut short the disease.

In the few cases in which this abortive treatment fails, or when the patient is not seen until the algid stage has already set in, recourse must be had to subcutaneous injections (hypodermoclysis) of a saline solution containing three parts of carbonate of soda and four parts of chloride of sodium to 1,000 parts of distilled water of a temperature equal to, or a little above, that of the normal body. These injections are to be made into the subcutaneous tissues on each side of the body, in the subclavicular and in the ileocostal regions, and are to be repeated as long as the loss of fluid through the intestines continues.

A similar mode of treatment has been advocated by Professor Samuel of Königsberg, in a recent brochure.[2] He uses, however, six parts of chloride of sodium and only one of carbonate of soda to 1,000 of water, a solution which Cantani does not consider sufficiently alkaline to overcome the tendency to acidity of the blood. Cantani seems to have established his claims to priority in the use of this method, since he advocated it in an article in the journal Morgagni in 1867, and even before that time in his notes added to an Italian translation of Niemeyer in 1865.

In this connection mention may also be made of the fact that Surgeon-Major E. T. Kellat,[3] attempted to arrest the disease by injecting distilled water, at a temperature of 99° F., hypodermically or into the cavity of the peritoneum. The object he had in view was the production of an artificial anasarca and ascites that might supply the fluid drained away through the intestines.

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[1] L' Enteroclèsi tannica calda come cura abortiva del Cholera, etc. Naples, 1884. Il Cholera: Lettera del Prof. Arnaldo Cantani; Milano, 1884. Istruzioni Popolari concernenti il Choléra Asiatico: Napoli, 1884. La Cura del Cholera mediante l'Ipodermoclisi e l'Enteroclisi, 3d Edition, Naples, 1884.

[2] Die subcutane Infusion als Behandlungsmethode der Cholera, Stuttgart, 1883.

[3] Aitken's Practice of Medicine, London, 1880, vol. i., p. 742.

But to return to the writings of Cantani. He holds that a second indication in the treatment of cholera is the disinfection of the intestinal contents. He proposes to accomplish this by an injection thrown far up into the bowel of the following solution:

Crystallized Carbolic Acid, . . .	8 to 30 grains.
Alcohol, sufficient to dissolve it.	
Distilled water, ...	$3\frac{1}{2}$ pints.

Even larger amounts of carbolic acid may be used during the algid stage, when intestinal absorption is suspended, but caution is to be observed not to continue the use of such large doses of the acid after reaction sets in and resorption is established. He adds that, since all acids are destructive to the cholera bacillus, use may be made of those which are not poisonous, such as hydrochloric (a drachm to the pint), lactic (one to four drachms to the pint), or tannic (½ drachm to the pint). It is important that these injections should be warmed up to 100° or 104° F. At the same time the patient may sip from time to time a little muriatic or lactic acid lemonade.

Dr. Duboué,[1] of Pau, advises the use of pure tannin in four-grain doses taken as a prophylactic against the disease during cholera times. The drug should be given twice a day before the two principal meals. When premonitory diarrhœa occurs, the dose must be tripled or quadrupled. During the attack he recommends rectal injections of from 2 to 6 quarts of water, containing 15 grains of tannin to the quart, a method which will be seen to resemble the tannic acid enteroclysms just described.

Cantani's tannic acid treatment has been tried by a number of Italian physicians, and some of them appear to have obtained satisfactory results. Thus Dr. Vitone has published,[2] the results of his method of treatment at the Cholera Orphanage at S. Antonio a Tarsia. The children admitted to this institution came from the most infected parts of the city, and had lost one or both parents from cholera.

The writer asserts that in a large number of cases the cholera was promptly arrested by tannic acid clysters.

Dr. E. Villani also states that he has injected per rectum as much as half an ounce of tannic acid in two quarts of warm water, with invariably good results. The *modus operandi* of the treatment is attributed to the astringent power of tannic acid, and to its sterilizing the comma-bacilli, which need an alkaline solution for their development. The London Lancet of February 21, 1885, makes the following comment upon these publications: "Without entering into this theoretical disquisition, the clinical results appear to afford striking evidence of the efficacy of warm tannic acid clysters in the treatment of cholera."

But in spite of such favorable opinions regarding this method, it does not recommend itself to the practitioner for universal adoption in the treatment of the disease. On the other hand, in severe attacks a tentative trial may be made of it, as it has in its favor the fact that, when not too vigorously pushed, it is at least free from too great annoyance and danger. One practical point must not be forgotten, if recourse be had to large enemata, namely, the elevation of the hips above the level of the trunk, and the gradual introduction of the warm fluid.

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[1] Bulletin Général de Therapeutique, October 30, 1884.

[2] Il Morgagni, January, 1885.

In the successful treatment of cholera the principal indications, according to Dr. F. Jousseaume,[1] are to arrest the vomiting and diarrhœa and reëstablish the urinary secretion. To this end he gives a powder of 5 grains each of chalk and bicarbonate of potash dissolved in a little water, and immediately afterward half a glassful of water containing about 20 minims of nitric acid to the pint. Carbonic acid is thus set free in the stomach, which is the most effectual means of controlling vomiting. Nitric acid is an excellent remedy for diarrhœa and nitrate of potash is one of the best diuretics which we possess.

Among the extraordinary recommendations regarding treatment, we may mention those of Dr. F. X. Poznanski. This writer was sent by the Russian Government to study the cholera in the infected districts. He published in Naples[2] a brochure embodying the method employed by him in several epidemics with, he claims, excellent results. It is necessary, he says, to prevent stagnation of the blood in the vessels, and this is to be done by increasing the activity of the respiration and circulation. With this object in view he employs a snuff of veratrum album to cause sneezing. This act accelerates the circulation and expels a quantity of carbonic acid from the pulmonary atmosphere.

In the second place he advocates a rapid but moderate venesection. Bleeding, he maintains, diminishes the resistance which the blood offers to the action of the heart. That this practice has fallen into desuetude in the treatment of cholera is due rather, the author thinks, to ignorance of its efficacy than to its abuse in former times. Lastly he employs dilute hydrocyanic acid (2 per cent. strength) in doses of 5 to 20 drops, which he says strengthens the pulse and increases its rapidity by several beats in the minute; the respirations are also increased somewhat in frequency and depth. Since the action of the acid is very evanescent, it must be given at repeated intervals of ten or fifteen minutes. He also throws a spray of some alkaline solution into the buccal cavity with the idea of neutralizing the excess of carbonic acid.

M. Rodriguez Merino of Madrid, a telegrapher, has given to the world his peculiar views in a little pamphlet.[3] Ozone, he says, is one of the best of disinfectants, solely because it creates electricity—and indeed all disinfectants owe their properties to the fact that they produce electricity. Therefore, why not give electricity in the first place? Accordingly the author suggests that cholera patients be put together hand in hand and then be charged with electricity by means of a Ruhmkorff coil. The strength of the current is to be regulated according to the needs of each case or batch of cases. This procedure is also recommended as a prophylactic.

The extensive employment of ozone as a disinfectant rather than a curative agent, is advocated by Dr. Onimus.[4] He says during the prevalence of cholera, there is always an appreciable diminution of atmospheric ozone. This deficiency he seeks to supply by placing in hospital wards, private dwellings, etc., dynamo-electric machines that generate as much ozone as may be needed for particular purposes. He says that it purifies the air, and acts as a stimulant upon patients. He does not claim that it cures cholera, any more than the absence of ozone from the atmosphere gives rise to the disease.

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[1] Du Choléra. Traitement Nouveau, Guérison. Paris, 1884.

[2] Diagnosi profillaticae terapeutica del colera epidemico. Per Fr. X. Poznanski. Napoli, 1884.

[3] La Electricidad y el Colera. Madrid, 1884.

[4] Ozone et Choléra. Paris, 1884.

It would be unprofitable and tiresome to examine further the various suggestions regarding the treatment of cholera that have come to light within the past two years. All the most important writings of different authors have been alluded to.

In reviewing the entire subject, candor compels the admission that the real additions to our knowledge concerning the rational treatment of the disease have amounted to little or nothing. There is no doubt that the list of useless medicaments and measures has been still further extended, and so far we have to record at least a negative gain.

But if Koch's doctrine has thus given no direct stimulus to the practical management of the disease, we cannot ignore the fact that in accepting it, we deal more intelligently with our patients than was possible before. Still, the chief interest and importance of future cholera research will undoubtedly center around the subject of effectual scientific prophylaxis.

Protective Inoculation against Cholera.—Before closing, we may briefly allude to "cholera vaccination," which was brought prominently before professional notice only a short time ago. The subject has already created considerable excitement in Europe, and especially in Spain, where the protective power of inoculation with attenuated cholera-virus has been made the subject of recent experimental inquiry, culminating in the inoculation of several human beings.

Dr. Ferrán[1] has made a careful study of the biology of the comma-bacillus, and has even discovered certain new forms of development of this microbe. But the main interest of these Spanish investigations naturally attaches to his inoculations with the attenuated virus of cholera. He attempted, as in vaccination, to produce a modified form of the disease, which would effectually protect the individual against the acquisition of the graver malady. While neither Ferrán himself nor his disciples claim to have already achieved unequivocal success, they nevertheless assert that they have obtained decidedly encouraging results.[2]

Dr. Gimeno, in a recent issue of La Crónica Médica, and Carreras-Solá, in La Revista de las Ciencias Médicas, also contribute articles on this new phase of the subject. Gimeno asserts that the comma-bacillus of Koch is only one form of development of an organism, that does not even belong to the order of schizomycetes. It should be classed rather with the cryptogamic peronosporeæ, and since Ferrán is credited with having made this discovery, it is suggested in future to speak of the Peronospora Ferrani, in place of Koch's comma-bacillus, when alluding to the microbe of Asiatic cholera.

Carreras-Sola says that "this microphyte vegetates without doubt in moist earth and mud, and amongst the cryptogamic vegetations of the banks and bottoms of ponds and rivers. In the first place, the medium being great and constantly renewed, the plant has always more than enough oxygen and organic material to sustain life. On the other hand, the products of its denutrition being extraordinarily diluted, it is not disturbed by them, which otherwise would seriously oppose its development. Placed in these conditions, and provided the temperature be not too low, it can

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[1] La Independencia Médica, Barcelona, March 1 and 11, 1885.

[2] Revista de las Ciencias Médicas, and El Siglo Medico, March, 1885.

in a few hours give origin to an infinite number of oöspheres replete with comma-bacilli producing granulations so small at first as to pass through porcelain filters (biscuit), when new, and at a pressure of less than a column of 10 metres. Two drops of the cultivation-fluid, filtered through one of these apparatuses, infect in forty-eight hours a tube of broth submitted to a temperature of 98.6° F. giving rise to characteristic spirilla. The influence of low temperatures paralyzes the work of segmentation, but the filaments or spirals already formed, being still nourished, engender oögonia which, even at these temperatures, are converted into oöspheres with granulations which are transformed into comma-bearing muriform bodies, which thus complete the circle of evolution."[1]

The Medical Record of April 11, 1885, in an editorial account of Ferrán's experiments, says:

"The first to submit himself to this somewhat hazardous experiment was Dr. Sereñana, who, on February 23 of the present year, received an injection into each arm of half a cubic centimetre of the attenuated virus. In less than three hours, he states, he began to experience severe pain in the posterior region of the arms, which gradually increased and rendered movement of the limbs difficult. At the end of seven hours he had a slight chill, accompanied by a feeling of general languor, elevation of temperature, rapid pulse, insomnia and headache. This condition remained for a little more than twenty-four hours, when there was a rapid abatement of all the symptoms, both local and general. Dr. Jacques was the second to receive the virus, and although he was injected in one arm only with half a cubic centimetre, his symptoms were even more pronounced than those of the first experimenter, and he also had slight cramps and nausea. Dr. Bertram, of Rubio, likewise submitted to the injection and experienced similar effects. An examination of the blood eighteen hours after inoculation revealed the presence of micrococci, said by Ferrán to be the first form assumed by the comma-bacillus when injected into the living organism.

"At the expiration of nine days two of these persons submitted to a reinoculation with negative results, while four others, who received primary inoculations with the same attenuated virus at this time, suffered from symptoms of considerable intensity. About two hours after the inoculation pain was felt in the arms, and toward evening, the injection having been practiced shortly before noon, the temperature rose, the pulse increased in frequency, there were headache, languor, slight chills, and nausea. Later there was a rapid fall of temperature, and the hands and feet grew cold and presented a marbled appearance; at the same time the headache and nausea increased and were accompanied by complete anorexia. Some of the subjects had also slight cramps in the calves of the legs. In about forty-eight hours all these symptoms had passed away. The highest temperature recorded was 102° F., and the pulse 125."

Obviously these experiments are so few in number that it would be quite premature to venture on any positive conclusions regarding their value. It is to be borne in mind above all things that cholera has not hitherto been shown to be an inoculable blood-disease, in the sense of maladies like septicæmia, small-pox, anthrax, etc. The alleged discovery of the protective influence of an attenuated cholera-virus should not, therefore, be permitted to awaken a dangerous notion of false security. It is, of course, by no means impossible that we are on the threshold of a new discovery, that future experimental research will prove to be of inestimable value. But at the present writing we must still urge the rigid enforcement of well-known sanitary rules in preference to the hypothetical protection conferred by cholera vaccination.

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[1] London Medical Record, April 15, 1885.

A leading English journal[1] expresses its views regarding this subject in the following words of warning: "The profession in Spain would do far more to protect their country from an epidemic if they urgently pressed on the authorities to undertake sanitary measures in the towns, than by lulling people into a fancied security by spreading the belief that inoculation will protect an individual from the disease. If cholera does visit Spain they will be wofully undeceived."

From the evidence *now* before us we can only express our concurrence in the opinions just quoted. Nevertheless, we are not justified in claiming that this new phase in the life history of the cholera microbe is destined to remain barren of beneficial results. But in dealing with a subject of such supreme importance as cholera prophylaxis, we must ever be on our guard to avoid confounding alluring possibilities with demonstrable facts.

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[1] The Lancet, May 2, 1885.

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